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IMPROVEMENT IN THE FUNDAMENTALS OF ARITHMETIC

Submitted by

Florence Elsie Drew

(B.S. in Ed., Boston University, 1935)

In partial fulfillment of requirements for the degree of Master of Education

1942

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CHAPTER I

INTRODUCTION

1. Purposes of Arithmetic Teaching:- One of the first records of teaching arithmetic in the schools of America was that of the New Amsterdam Colony. The Dutch West India Company, as the controlling factor in the colony wanted men trained in figuring to act as "keepers and assistants".[1/] So arithmetic seems to have been introduced into the schools because of its practical value as a tool in business. From then until now the purposes in teaching arithmetic have changed from time to time with different emphases predominating.

McMurry says, "Arithmetic is one of the chief means by which one can reach an understanding of the life of a miner, or a farmer, or a store-keeper. The answers to problems describes their lives."[2/]

Klapper says,

> "Teachers of arithmetic have long recognized that this subject held a domi-

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1/ W. H. Kilpatrick, The Dutch Schools of New Netherlands and Colonial New York, United States Bureau of Education, Bulletin 12, 1912.

2/ F. M. McMurry, "What Is the Matter with Arithmetic"? Education, 54: 449-451, (April 1934).

> nating place in elementary education and have evolved a series of values to justify its position. These values may be classified as:
>
> 1. The social values
> 2. The traditional values, which include:
> (a) The disciplinary values
> (b) The pleasure values
> (c) The cultural values
> (d) The preparatory values."1/

Then again, in summary, Klapper says,

> "Our study has sought to justify the teaching of arithmetic on a fivefold basis: the practical, the disciplinary, the pleasure, the conventional, and the preparatory. We have presented here no coordinate set of values. There is a relativity of worth that must be clearly perceived and constantly kept in view as the guiding principle in teaching and selecting the subject matter of arithmetic. We are rapidly making for a new arithmetic. The present day interpretation of the doctrine of the transfer of abilities, the view of education as a socializing function, the demands of industry, the more sympathetic comprehension of child life-all these are cooperating to humanize the subject, and to teach that the practical value of arithmetic is primary. To it, all other values must bend. A course of study in arithmetic, selected and organized with the utilitarian aim in view, may be so taught that all other values are attained to their fullest measure."2/

Stone, earlier, in 1918, expressed the relative importance of these values concisely. He says,

---

1/ Paul Klapper, The Teaching of Arithmetic, pp. 4-18.

2/ Ibid. pp. 4-18.

> "The emphasis in arithmetic is now placed upon the practical values of the subject. That does not mean that all the older aims, as discipline, pleasure, culture, and preparatory values, are now wholly ignored; but it does mean that the emphasis has shifted from these to the practical in the broad sense of that term. But in so doing, whatever claims of recognition any of the older values have, may be taken care of when teaching the subject from the practical standpoint."1/

No matter which aim may have predominated at a particular time, all aims hoped for the mastery of the four fundamental processes.

2. Why 100% Accuracy?:- What are the reasons why 100% accuracy should be the goal in handling the fundamental processes? The answers are several.

Klapper says, "Because of the nature of mathematics the desired standard of accuracy in arithmetical operations must be perfection."2/ Again he says,

> "Few complaints against current teaching come with greater frequency than those directed against the teaching of arithmetic. It is charged that the graduate is inaccurate, unduly slow in his calculations, and unable to meet a new arithmetical situation, even if only slightly varied from the type."3/

Osburn says,

> "Business men everywhere deplore the

1/ J. C. Stone, The Teaching of Arithmetic, p. 12.

2/ Paul Klapper, op. cit., p. 67.

3/ Ibid., p. 112.

> lack of ability of their employees to perform with accuracy even the simplest of arithmetic processes.---Yet the people are paying a substantial price to have their children made masters of these skills which are fundamental to successful living."1/

Morton says,

> "It is held that the ordinary individual has little use for computational skill because most of his figuring is done for him by someone else who has a machine at hand. Our modern complex society supplies far more situations which involve computation than did the society of preceding generations. To be sure, most of the computing can be left to the expert but there is always the possibility, amounting sometimes to a probability, that the individual will not only have his computing done for him by the expert but that he himself will be 'done' by the expert. Instances in which customers receive the wrong change after making a purchase are more common than most persons realize. Few persons know how costly installment buying is or how high the charges are which are assessed by concerns making a specialty of lending small sums of money. The advantage or disadvantage of purchasing large or small quantities of various commodities is seldom realized. Since a very small proportion of the population yet has access to computing machines, the ordinary individual must do his computing by the methods of elementary school arithmetic or not at all. Instead of having less need for skill in computation, we have far greater need than was the case with earlier generations. We should set higher computational goals in school rather than lower. In our zeal for understand-

1/ W. J. Osburn, Corrective Arithmetic, p. 1.

> ing, we should not neglect the skills. Skill in fundamentals is worthwhile; and skill with understanding is education."1/

Brown and Coffman say,

> "The pupil who passes the age of eleven or twelve without the ability to perform the fundamental operations with facility and a relatively high degree of accuracy is quite likely to be handicapped in these respects throughout life."2/

Overman says,

> "Sometimes a mere informational knowledge of a subject is all that is needed, but in the case of the fundamental facts and processes of arithmetic this is not sufficient. Merely to be able to add is not enough; to meet the demands of modern life one must be able to add accurately and with a reasonable degree of speed. In order to do this one must be able to handle all of the facts and steps involved in the process instantly and without having to take time to reason them out logically. In short, to meet the needs of life an automatic control of the fundamental facts and processes are necessary."3/

Wilson and others in discussing a change in curriculum to reduce the amount of drill material from the useless topics to the more socially useful say,

> "Limiting grade work in arithmetic to the mastery of the socially useful not only will remove a great burden from the backs of children but will con-

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1/ R. L. Morton, Teaching Arithmetic in the Elementary School, pp. 22,23.

2/ J. C. Brown, and L. D. Coffman, How to Teach Arithmetic, p. 115.

3/ J. R. Overman, Principles and Methods of Teaching Arithmetic, p. 11.

> tribute to better teaching and a better mental hygiene program in the schoolroom. Thus other values of good teaching such as favorable attitudes toward learning, more fundamental thinking, and a more integrated and purposeful personality will be saved."1/

Then again Wilson says, "The child will enter high school better prepared to succeed because of favorable attitudes and because he comes with the most needed tools perfectly learned."2/

"If 95 per cent of adult figuring is covered by the four fundamental processes, simple fractions, percentage, and interest, then obviously these are the processes for drill mastery."3/

Kilpatrick says,

> "The kind of school we need must be a school of life, of actual experiencing----a place where pupils are active, where pupil enterprises form the typical unit of learning procedure, for purposeful activity is the typical unit of the worthy life wherever lived."4/

1/ By Wilson, Wise, Woody, Charters, Thorndike, Schorling, Bobbitt and others. For summaries of these various studies see G. M. Wilson, What Arithmetic Shall We Teach?, Chapters VII and X.

2/ G. M. Wilson, and Mildred B. Stone, and others, Teaching the New Arithmetic, p. 37.

3/ Ibid. p. 35.

4/ W. H. Kilpatrick, Education for a Changing World, pp. 96, 106, 112.

Melvin says,

> "The fundamental statement of educational philosophy of the modern school is the well known aphorism 'education is life'. Elementary school education is children's living. This brings home to us the fact that the living which goes on in school is really the beginning of living. It is not merely life but it is in the most obvious and direct sense a preparation for life. Rather we must say that education is life which is preparation for life."[1/]

If this is true that school is the beginning of living, then the preparation which the school makes should be consistent with the demands of life and should call for 100 per cent mastery of the fundamental processes used in life outside the schoolroom.

3. Can Pupils Achieve the 100% Goal?:- Many studies in corrective arithmetic show that children and students even at the high school[2/] and college[3/] levels have not and are not achieving 100 per cent accuracy in the fundamentals. But most of these studies also reveal the fact that the nor-

---

1/ A. Gordon Melvin, The Teacher's Technique, pp. 20, 21.

2/ R. H. Gillmore, "Corrective Arithmetic in Senior High School", Unpublished Master's thesis, Boston University, 1939.

3/ Myra B. Kite, "Corrective Load in Fundamentals of Arithmetic for University Students." Unpublished Master's thesis, Boston University, 1940.

mal person can, with the right practice, increase his efficiency and achieve the perfect goal or at least more nearly approach it.

Earle, in her thesis gives a good summary which is representative of work done in New England during the past seven years. She says,

> "In 1934, Bowdren[1/] studied and worked individually with five normal fifth and sixth grade pupils. She was able to bring each up to satisfactory work in arithmetic for his grade and succeeded in getting each to attain 100 per cent accuracy in the fundamentals.
>
> Pucko,[2/] in 1935, worked individually with children with low I.Q.'s who were definite 'problems' in arithmetic, According to him significant gain in time and score was made in all but one of the final tests.
>
> Soles,[3/] also in 1935, worked with twenty-three children who were failing in arithmetic. They were a random selection of fourth, fifth, and sixth grade children whose I.Q.'s ranged from 84 to 132. However he did not record the specific results of his attempts to improve their standing. His study includes a somewhat complete scheme of diagnostic and corrective measures for addition.
>
> In 1936, Caton[4/] diagnosed the errors made by fourth, fifth, and sixth grade pu-

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1/ Marion Bowdren, "Five Case Studies of Arithmetic Failures." Unpublished Master's thesis, Boston University, 1934.

2/ R. F. Pucko, "Five Case Studies of Arithmetic Failures." Unpublished Master's thesis, Boston University, 1935.

3/ Edward Soles, "Diagnostic and Corrective Measures in Addition." Unpublished Master's thesis, Boston University, 1935.

4/ Anne J. Caton, "How Much Time is Needed to Take an Average Fifth or Sixth Grade Pupil from Inaccuracy to 100% Accuracy in a Fundamental Process of Arithmetic." Unpublished Master's thesis, Boston University, 1936.

pils and worked remedially with a group of fifth and sixth graders. She concluded that her study justified the statement that every normal pupil in grades five and six can secure perfect mastery in multiplication if the teaching is satisfactory.

Randall,[1] in 1936, carried on a similar study at the Junior High School level. After testing a large group in addition and subtraction he selected a group of eighth grade pupils with high I.Q.'s and low scores in the fundamentals, with which to work. He showed that it is possible with pupils of higher than average intelligence to correct faults in factual knowledge and process skills with a reasonable expenditure of time and properly motivated remedial work.

These earlier studies, it will be seen, were carried on either with individuals or with small groups of children. Beginning in 1937 the scope of such studies was enlarged to include entire classes, and in 1938 and 1939 entire buildings and selected grades throughout entire school systems.

A forerunner of these larger studies was the W.P.A. project of 1936,[2] sponsored by Wilson, and carried on in fifteen different school systems in Greater Boston. A very small percentage of perfect scores was found. The conclusion was that there was need for a higher order of teaching than appeared to be common. In one city, City O, the results were different, showing a mean of 99.34 per cent and 89 per cent of perfect scores in addition, for example."[3]

1/ Joseph H. Randall, "Corrective Arithmetic in Junior High." Unpublished Master's thesis, Boston University, 1936.

2/ W.P.A. Project in Arithmetic, Yearbook of American Educational Research Association, 1937.

3/ Ruth T. Earle, "Study in Corrective Arithmetic in Grades IV, VI, and VIII." Unpublished Master's thesis, Boston University, 1940.

In 1940, Earle[1/] reports her own study carried on in grades four, six, and eight in the public schools of Newport, Rhode Island. This study has an aspect which is new to Boston University studies. A control group in addition to the experimental group was used; Earle worked remedially with two groups--a fourth and an eighth grade, and the regular classroom or arithmetic teacher worked with the others although she made some suggestions to them regarding the work. Her conclusions state that gains resulting from corrective procedures may be expected to be significant; that experimental groups make greater gains than control groups,- those who do not take time for practice procedures.

That similar studies are being carried on in other parts of the country is evidenced by such reports as Williams and Whitaker's.[2/] They report a study, made in eleven Chicago schools in 1936, in which arithmetic errors with remedial measures were considered. They emphasize individual diagnosis and state that when the instructor has found the difficulty, improvement and recovery may be confidently expected.

Bancroft[3/] carried on an experiment in a private co-educational day school, the University School of Cincinnati,

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1/ Op. cit.

2/ C. L. Williams, and R. L. Whitaker, "Diagnosis of Arithmetic Difficulties." Elementary School Journal, 37: 592-600, (April 1937).

3/ Marguerite C. Bancroft, "A Remedial Program for 100% Mastery." Unpublished Master's thesis, Boston University, School of Education, 1941.

Ohio, during the school year 1940-1941. Grades five through eight were included in the experiment, with a total enrollment of 66 pupils. She found that the majority of the children were in need of corrective work in all processes and that many achieved the 100 per cent goal at the end of the practice period.

Table I and Table II, partially a summary made by Earle,[1/] show the results of the initial testing in some of the more recent studies made at Boston University. They are restricted to the grades and processes with which this present study is concerned: namely, grades IV-VIII in addition, subtraction, and multiplication. For example, Bancroft's study[2/] deals with the division process but because the present study is not concerned with that process, the results of Bancroft's testing in division are omitted in these tables.

Table I is read as follows. In the addition process in the initial tests Hanley's fourth grade had a median score of 68 with a median time of 23 minutes; in the subtraction process they had a median score of 48 with a median time of 22 minutes. Tables II, III, and IV are read in a similar manner.

Table III and Table IV show the median and mean scores

1/ Op. cit.

2/ Op. cit.

TABLE I. Median Scores and Times of the Initial Testing for the Earlier Studies (columns 3-10) in*-Wilson Inventory and Diagnostic A. P., S. P., and M. P. Tests.

1 Grade	2 Test	3 Hanley 1938		4 Yar-brough 1938		5 Nelson 1938		6 Hough-ton 1939		7 Ridlon 1939		8 Ringer 1940		9 Earle 1940		10 Ban-croft 1941	
		Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV	A.P.	68	23											80	20		
	S.P.	48	22											60	15		
V	A.P.	76	15													84	13
	S.P.	96	22													76	12
	M.P.	64	30													68	20
VI	A.P.	88	11	84	11			80	11	84	10			92	11	88	7
	S.P.	88	10	88	9			92	9	88	7			92	8	88	6
	M.P.	84	33	76	14			64	20	60	13			76	14	84	13
VII	A.P.							88	13			88	9				
	S.P.							92	7			92	6				
	M.P.							76	18			72	10				
VIII	A.P.					92	8	96	7			92	8	92	8	92	6
	S.P.					92	7	96	7			99	13	92	5	92	5
	M.P.					84	10	84	12			84	10	84	9	84	10

* Medians taken to nearest whole numbers. No re-tests

TABLE II. Mean Scores and Times of the Initial Testing for the Earlier Studies (columns 3-11) in*-Wilson Inventory and Diagnostic A. P., S. P., and M. P. Tests.

Grade [1]	Test [2]	W.P.A. [3] 1936		Hanley [4] 1938		Yarbrough [5] 1938		Nelson [6] 1938		Houghton [7] 6,7,8		Ridlon [8] 1939		Ringer [9]		Earle [10] 1940		Bancroft [11] 1941	
		Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV	A.P.			65	28											78	22		
	S.P.			46	22											56	17		
V	A.P.			81	17													83	14
	S.P.			75	16													72	18
	M.P.			58	42													65	21
VI	A.P.	89	9	88	13	86	12			79	13	83	10			90	12	87	9
	S.P.	88	7	84	11	85	9			87	10	84	8			89	9	84	8
	M.P.	77	11	82	33	75	16			56	21	58	14			75	15	77	14
VII	A.P.									84	14			88	9				
	S.P.									89	8			92	6				
	M.P.									71	19			72	10				
VIII	A.P.							88	8	94	8			89	8	88	8	90	7
	S.P.							86	7	95	6			88	5	92	5	90	7
	M.P.							80	10	81	12			83	5	81	9	84	10
		No retests						No retests											

* Means taken to nearest whole number.

TABLE III. Median Scores and Times of the Final Testing for the Earlier Studies (columns 2-9) in the Wilson Inventory and Diagnostic A. P., S. P., M. P., Tests.

1 Grade	2 Test	3 Hanley 1938		4 Yarbrough 1938		5 Houghton 1939		6 Ridlon 1939		7 Ringer 1940		8 Earle 1940		9 Bancroft 1941	
		Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV	A.P.	80	16									92	15		
	S.P.	84	15									96	11		
V	A.P.	100	6											100	6
	S.P.	100	5											100	5
	M.P.	100	7											96	9
VI	A.P.	92	12	96	8	96	7	92	9			92	9	100	5
	S.P.	96	9	96	7	100	7	96	6			96	6	100	4
	M.P.	84	15	92	11	100	12	84	10			88	11	96	8
VII	A.P.					*				100	15				
	S.P.														
	M.P.														
VIII	A.P.					100	6			100	9	96	7	100	5
	S.P.					100	5			100	7	100	5	100	4
	M.P.					100	8			100	10	96	9	96	7

* Not indicated because 50% or more are at a given score and time.

TABLE IV. Mean Scores and Times of the Final Testing for the Earlier Studies (columns 2-9) in the Wilson Inventory and Diagnostic A. P., S. P., M. P. Tests.

1 Grade	2 Test	3 Hanley 1938		4 Yarbrough 1938		5 Houghton 1939		6 Ridlon 1939		7 Ringer 1940		8 Earle 1940		9 Bancroft 1941	
		Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV	A.P.	80	18									89	16		
	S.P.	74	20									87	13		
V	A.P.	84	13											94	7
	S.P.	87	11											97	6
	M.P.	75	18											92	10
VI	A.P.	90	13	96	9	95	7	91	10			90	10	94	7
	S.P.	91	10	96	7	99	7	93	7			95	6	96	4
	M.P.	80	17	92	12	96	12	83	11			88	12	94	9
VII	A.P.					97	9			100	9				
	S.P.					99	6								
	M.P.					98	9								
VIII	A.P.					99	6			99	9	95	8	97	5
	S.P.					99	4			99	7	99	5	99	4
	M.P.					99	9			96	10	94	10	95	7

TABLE V. Number of Children in Some 1936-1941 Boston University Studies.

Study	W.P.A. 1936	Hanley 1938	Yar-brough 1938	Nelson 1938	Hough-ton 1939	Ridlon 1939	Ringer 1940	Earle 1940	Ban-croft 1941
No. of children	17,700	1124	127	1215	80	194	27	1026	66

of some of the more recent studies in the re-testing. By comparing Table III with Table I, one sees improvement in the median scores. For example, Hanley's children in the addition process show an improvement of 16 points in their median scores. By comparing Table II with Table IV, one sees an improvement in mean scores.

Table V, partially a summary made by Earle,[1/] shows the number of children included in the 1936-1941 studies. Table V shows the number of children in grades four through eight which have been used in some of the Boston University studies between 1936 and 1941.

From the preceding summaries and Tables I-IV one sees that children, through the correct use of the drill process, can be brought to the 100 per cent goal or more nearly to the goal. It is also evident that for most teachers results are so unsatisfactory, that further study of this problem is justified.

1/ Op. cit.

CHAPTER II

THE INITIAL TESTING

1. Purpose of the Study:- The addition, subtraction, and multiplication processes are so much used in adult life that their mastery should be accomplished.

Wilson, Stone, and others say, "Ninety per cent of adult figuring is covered by the four fundamental processes--multiplication, addition, subtraction, and division."[1/]

Studies have proved that children can make much improvement in the use of the fundamental processes and that a larger percentage of pupils can achieve the 100 per cent goal. This is one more study which hopes to see if another group of children--this time a rural group--can be brought nearer to the 100 per cent level through systematic drill or practice.

2. The Setting of the Study:- The study takes place in northern Vermont in the North District of Caledonia County in the school year, 1941-1942.

Different types of schools are represented in the ex-

1/ G. M. Wilson, Mildred B. Stone, and others, op.cit., p. 97.

periment: two one-room buildings, three two-room buildings, one three-room building, and an eight-room building. A one-room school has one teacher for several grades, possibly all eight; a two-room school has two teachers, one for the first four grades and one for the four upper grades; a three-room school has a primary group usually comprised of the first three grades, an intermediate room comprised of the fourth and fifth grades, and a grammar room comprised of the three upper grades. In a four-room school there are two grades under one teacher; and in an eight-room school, a teacher for each single grade.

Grades four through eight are included in this experiment, with a total enrollment of 313 pupils. The enrollment is divided as shown in Table VI. It is read as follows. At the left are the names and the types of schools, and at the top, in ascending order, are the grades. Thus one reads that the Fletcher School is a one-room building with 3 pupils in grade four, 2 pupils in grade five, 5 pupils in grade six, 2 pupils in grade seven, and 2 pupils in grade eight, with a total enrollment of 14 pupils.

TABLE VI. Distribution of Enrollment in the Various Schools Used in the Study.

Schools	Grades					Total
	IV	V	VI	VII	VIII	
Fletcher (one-room)	3	2	5	2	2	14
Red Village (one-room)	1	3	4	1		9
East Burke (two-room)	7	2	8	8	3	28
Sheffield (two-room)	6	5	5	3	4	23
Wheelock (two-room)		3	5	3	6	17
Lyndon Graded School (three-room)	11	18	12	7	10	58
Lyndon Center Graded School (four-room)	9	5	14	10	14	52
Lyndonville Graded School (eight-room)	22	24	23	22	21	112
Total	59	62	76	56	61	313

The enrollment is also shown according to grades in the various types of schools in Table VII. It is read as follows. At the left are listed the types of schools, and at the top, in ascending order, are the grades. Thus one reads that in one-room schools there are 4 pupils in grade four, 5 pupils in grade five, 9 pupils in grade six, 3 pupils in grade seven, and 2 pupils in grade eight with a total of 23 pupils in one-room schools. Table VII shows the total number of pupils in

TABLE VII. Distribution of Enrollment According to Grades in the Various Types of Schools Used in the Study.

Types of School	Grades					Total
	IV	V	VI	VII	VIII	
One-room	4	5	9	3	2	23
Two-room	13	10	18	14	13	68
Three-room	11	18	12	7	10	58
Four-room	9	5	14	10	14	52
Eight-room	22	24	23	22	21	112
Total	59	62	76	56	61	313

each grade in all types of schools; for example, there are 59 fourth grade pupils in one, two, three, and four-room schools.

The regular room teachers administered the tests and gave the remedial work after careful instructions and directions. The purpose here is to show the need of a remedial program and to give a picture of the progress made, through that program, either in the addition or the multiplication process.

Since it has been impossible to secure the intelligence quotients of all the children, this information has been disregarded. The names of a very few pupils below normal

ability have been withdrawn from the study.

3. Procedure in the Testing:- The initial testing of the children in the fundamentals took place the first of December, 1941. For this the Wilson Inventory and Diagnostic Tests in addition (A. P. Test), subtraction (S. P. Test), and multiplication (M. P. Test)* were used. All children in the fourth grade and above were tested in the addition and the subtraction processes; and all those in the fifth grade and above in the multiplication process.

An analysis of these tests reveals the fact that they cover all of the primary facts of each process used, and also cover the essential process difficulties. They are of further advantage in that they require short periods of time for administration and have no time limits.

In the preliminary instructions for testing the children were told by their teachers to do their best, to be as accurate as possible, to move forward with their work taking whatever time was necessary to complete the test, and to check their work. The time needed for doing the test, un-

* Copies of these tests are to be found at the end of this study. In the remainder of the study the tests will be referred to by the letters, A. P. Test, S. P. Test, M. P. Test or by the names of the processes involved.

checked, was recorded at the top of the test paper.

4. Results of the Testing:- From the testing in December the following information was obtained. The results are grouped according to grades from all the various types of schools.

A Fourth Grades -- 57 pupils

1. Addition Process Test (A. P. Test)

The scores on the A.P.Test ranged from 36 per cent to 100 per cent, with a median of 76 per cent and a mean of 77.7 per cent. Two pupils, or 3.5 per cent of all fourth grade pupils achieved the desired goal, 100 per cent accuracy.

The time ranged from 8 minutes to 27.5 minutes for 58 pupils, one pupil failing to record his time. The median was 15 minutes and the mean 15.9 minutes. The standard for fourth grade is 15 minutes, preferably 8 minutes.

The results of the initial testing in addition for the fourth grades are shown in Table VIII. This and the following Tables are read in this manner. The range of scores in grade four are arranged at the left in descending order. At the top, ascending from left to right, is the range of time in minutes. Thus one reads from the score column in Table VIII for fourth grade on the addition process test, that 2 pupils received a score of 100 per cent, one completing it in 10 minutes and the other in 14.5 minutes. Besides this information, the first summary column at the right gives the total number of pupils receiving the various scores, and in the second column, this frequency is expressed as per cent of the class receiving the various scores. At the bottom of the Table will be found the number of children com-

TABLE VIII. Distribution of Scores Relative to Time for All Fourth Grades, on Wilson A. P. Test -- Initial Test.

Time in Minutes

Score	8	9	9½	10	10½	11½	12	12½	13	14	14½	15	15½	16	16½	17	17½	18
100				1							1							
96					1			1				1						
92	2									1								
88		1									1			1			1	
84	1								1	1							1	1
80					1	1				1	1				1			
76	1						1					1					1	
72			1					1			1					1	1	
68	1										1	1			1	1		
64															1			
60			1							1								
56																1		
52																		
48																		
40																		
36													1					
Total	5	1	2	1	2	1	1	2	1	4	5	3	1	1	3	3	4	1

Score	18½	19	20	21	21½	22	25	26	27	27½	No Time	Total	Per Cent
100												2	3.5
96												3	5.2
92												3	5.2
88		1								1		6	10.5
84			1				1					7	12.2
80												5	8.7
76	1		1									6	10.5
72					1					1		7	12.2
68								1				6	10.5
64												1	1.7
60											1	3	5.2
56					1							2	3.5
52				2								2	3.5
48													
40		1				1						2	3.5
36									1			2	3.5
Total	1	2	2	2	2	1	1	1	1	2	1	57	99.4

(continued on next page)

TABLE VIII. (concluded)

Range in Score	36 to 100 Per Cent
Median Score	76 Per Cent
Mean Score	77.7 Per Cent
Per Cent of Hundreds	3.5
Range in Time	8 to 27.5 Minutes
Median Time	15 Minutes
Mean Time	15.9 Minutes
Standard Time	15 Minutes (Preferably 8 Minutes)

(56 Pupils)

TABLE IX. Distribution of Scores Relative to Time for All Fourth Grades on the Wilson S. P. Test -- Initial Test.

Time in Minutes

Score	6	7	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16
100				2	1						1							
92	1	1				2												
88	1					1		1	1			1	1					
84								1						1			1	1
80									1					1				
76										1								
72		1										1						
68																		1
64				1	1				2				1			1		
60						1						1						
56												1						
52																		
48						1												
44		1									1							
40								1										
36						1	1											
32					1						1							
28																		1
24						1												
20								1										
16																		
12								1										
8										1		1						
4			1															
0																		
Total	2	3	1	3	3	7	1	5	4	2	3	5	2	2		1	1	3

(continued on next page)

TABLE IX. (concluded)

Score	16?	17	18	18?	21	22	27	28	No Time	Total	Per Cent
100		1		1						6	10.1
92	1		1		1					7	11.0
88										6	10.1
84										4	6.8
80										2	3.4
76										1	1.7
72						1				3	5.0
68										1	1.7
64										6	10.1
60										2	3.4
56		1								2	3.4
52											
48										1	1.7
44										2	3.4
40							1			2	3.4
36										2	3.4
32										2	3.4
28										1	1.7
24										1	1.7
20								1		2	3.4
16			1							1	1.7
12										1	1.7
8										2	3.4
4										1	1.7
0									1	1	1.7
Total	1	2	2	1	1	1	1	1	1	59	99.3

Score		Time (58 pupils)	
Range	0 to 100 Per Cent	Range	6 to 28 Minutes
Median	68 Per Cent	Median	11.7 Minutes
Mean	63.3 Per Cent	Mean	13.3 Minutes
Per Cent of Hundreds (58 Pupils)	10.1	Standard	15 Minutes (Preferably 8 Minutes)

pleting the test within each time limit. The Table also gives information as to range of scores and time with the median and mean of each.

2. Subtraction Process Test (S. P. Test)

The scores on the S.P.Test ranged from 0 per cent to 100 per cent, with a median of 68 per cent and a mean of 63.3 per cent. Six pupils, or 10.1 per cent of the class, achieved the desired goal, 100 per cent.

The time ranged from 6 minutes to 28 minutes, with 1 pupil failing to record his time. The median for 58 pupils was 11.7 minutes and the mean, 13.3 minutes. The standard for this grade is 15 minutes, preferably 8 minutes.

The results of the initial testing in subtraction for the fourth grades are shown in Table IX.

B <u>Fifth Grades</u>

1. Addition Process Test (A. P. Test)

The scores on the A.P.Test ranged from 44 per cent to 100 per cent, with a median of 84 per cent and a mean of 80.6 per cent. Four pupils, or 6.4 per cent of all the fifth grade children, achieved the desired goal, 100 per cent accuracy.

The time ranged from 2 minutes to 20 minutes, the median being 10.2 minutes and the mean 10.5 minutes. The standard time for fifth grade is 15 minutes, preferably 6 minutes.

The results of the initial testing in addition for all fifth grades are shown in Table X.

2. Subtraction Process Test (S. P. Test)

TABLE X. Distribution of Scores Relative to Time
for All Fifth Grades on Wilson A.P. Test.
Initial Test.

Time in Minutes

Score	2	4½	5	5½	6	7	7½	8	8½	9	10	10½	11	11½	12	12½	13	13½	14	15	16	16½	17	19	20	Total	Per Cent
100					1		1			1									1							4	6.4
96			1		2		2	1		1	2		1													10	16.1
92	1		1						1									1								4	6.4
88				1				1		1					3		1		1	2						10	16.1
84				1				1					1		2											5	8.0
80										1	1					1	1									4	6.4
76								2					2	1							1			1		7	11.3
72						1					1													1		3	4.8
68								1												1	1				1	4	6.4
64		1											1										1			3	4.8
60								1				2														3	4.8
56									1		1									1						3	4.8
48																			1							1	1.6
44																	1									1	1.6
Total	1	1	2	2	3	1	3	7	2	4	5	2	5	1	5	1	3	1	3	4	2		1	2	1	62	99.5

Score

Range 44 to 100 Per Cent
Median 84 Per Cent
Mean 80.6 Per Cent
Per Cent of Hundreds 6.4

Time

Range 2 to 20 Minutes
Median 10.2 Minutes
Mean 10.5 Minutes
Standard 15 Minutes
(Preferably 6 Minutes)

TABLE XI. Distribution of Scores Relative to Time for All Fifth Grades on Wilson S. P. Test.- Initial Test.

Time in Minutes

Score	3	3½	4	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	13½	14½	15	16	18	No Time	Total	Per Cent
100	1					1														1							3	4.7
96		2	1			1		1		1	1			2													9	14.2
92	1	1				1	1				1			1										1			7	11.1
88					1		1			1										1							4	6.3
84				1	1	1		3		2																	8	12.7
80														1			1	1									3	4.7
76						1		1				1						1				1					5	7.9
72	1							1					1			1											4	6.3
68												1					1	1	1	1							5	7.9
64									1					1													2	3.1
56								1																	1		2	3.1
48																				1							1	1.6
44												1															1	1.6
40																				1			1				2	3.1
36														1												1	2	3.1
32								1																			1	1.6
24															1												1	1.6
20																					1						1	1.6
16																												
12									1																		1	1.6
8											1																1	1.6
Total	3	3	1	1	2	5	2	8	2	4	3	3	1	6	1	1	2	3	1	5	1	1	1	1	1	1	63	99.4

(continued on next page)

TABLE XI. (concluded)

Range in Score	8 to 100 Per Cent
Median Score	80 Per Cent
Mean Score	73.9 Per Cent
Per Cent of Hundreds	4.7
Range in Time	3 to 18 Minutes
Median Time	8.5 Minutes
Mean Time	8.7 Minutes
Standard Time	12 Minutes (Preferably 6 Minutes)

(62 Pupils)

The scores on the S.P.Test ranged from 8 per cent to 100 per cent, with a median of 80 per cent and a mean of 73.9 per cent. Three pupils, or 4.7 per cent of all fifth grade pupils, achieved the desired goal, 100 per cent.

The time ranged from 3 minutes to 18 minutes, with a median of 8.5 minutes and a mean of 8.7 minutes for 62 pupils as one child failed to record his time. The standard time for the fifth grade is 12 minutes, preferably 6 minutes.

The results of the initial testing in subtraction for all fifth grades are shown in Table XI.

3. Multiplication Process Test (M. P. Test)

The scores on the M.P.Test ranged from 28 per cent to 100 per cent, with a median of 76 per cent and a mean of 73.4 per cent. One pupil, or 1.7 per cent of all fifth grade pupils, achieved the desired goal, 100 per cent accuracy in multiplication.

The time ranged from 4 minutes to 30 minutes for the group, with a median of 12 minutes and a mean of 12.6 minutes. The standard for the fifth grade is 20 minutes, preferably 8 minutes.

The results of the initial testing in multiplication for all fifth grades are shown in Table XII.

C <u>Sixth Grade</u>

1. Addition Process Test (A. P. Test)

The scores on the A.P.Test ranged from 28 per cent to 100 per cent, with a median of 84 per cent and a mean of 82.8 per cent. Nine pupils, or 12 per cent of the

TABLE XII. Distribution of Scores Relative to Time for All Fifth Grades on Wilson M. P. Test. -- Initial Test.

Time in Minutes

Score	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	13	13½	14
100					1															
96	1						1		1											
92					1															1
88																1		1		
84											1									1
80		1	1				1						2				1	3		2
76		1	1												1	1			1	1
72																1	1			
68																	1			
64													1		1	1				
60													1							
56							1		1		1			1						
52																				
48				1																
32																				
28																		1		
Total	1	2	2	1	2	2	1	2	1	1	1	1	4	2	4	3	5	1	5	

Score	14½	15	17	18	19	20	21	22	25	30	Total	Per Cent
100											1	1.7
96		1			1		1				5	8.9
92									1		3	5.3
88		1									3	5.3
84									1		3	5.3
80		1									12	21.4
76		1			1						8	14.2
72											2	3.5
68											1	1.7
64	1										4	7.1
60											1	1.7
56				1		1					6	10.7
52		1									2	3.5
48										1	2	3.5
32			1					1			2	3.5
28											1	1.7
Total	1	5	1	1	2	1	1	1	2	1	56	99.0

(continued on next page)

TABLE XII (concluded)

Range in Score	28 to 100 Per Cent
Median Score	76 Per Cent
Mean Score	73.4 Per Cent
Per Cent of Hundreds	1.7
Range in Time	4 to 30 Minutes
Median Time	12 Minutes
Mean Time	12.6 Minutes
Standard Time	20 Minutes (Preferably 8 Minutes)

sixth grade group, achieved the desired goal, 100 per cent.

The time ranged from 3 minutes to 22.5 minutes for the 74 children, 1 pupil failing to record his time. The median was 10 minutes and the mean 10.1 minutes. The standard for sixth grade is 12 minutes, preferably 5 minutes.

The results of the initial testing in addition for all sixth grades are shown in Table XIII.

2. Subtraction Process Test (S. P. Test)

The scores on the S.P.Test ranged from 12 per cent to 100 per cent, with a median of 92 per cent and a mean of 84.4 per cent. Twelve pupils, or 16 per cent of the sixth grade group, achieved the desired goal, 100 per cent.

The time ranged from 3.5 minutes to 21 minutes, 1 pupil forgetting to record his time. The median was 7 minutes and the mean 8 minutes. The standard for sixth grade is 12 minutes, preferably 5 minutes.

The results of the initial testing in subtraction for all sixth grades are shown in Table XIV.

3. Multiplication Process Test (M. P. Test)

The scores on the M.P.Test for all sixth grades ranged from 12 per cent to 96 per cent, with a median of 80 per cent and a mean of 75.6 per cent. No pupil achieved a perfect score.

The time ranged from 4.5 minutes to 24 minutes for the 74 pupils. 1 pupil forgetting to record his time. The median was 12 minutes and the mean 12.6

TABLE XIII. Distribution of Scores Relative to Time for All Sixth Grades on Wilson A. P. Test. -- Initial Test.

	Time in Minutes																										
Score	3	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	15	15½	16½	19	22½	No Time	Total	Per Cent
100	1	1	1	2		1					1			1								1				9	12.0
96	1		1		1	1				2				2												8	10.6
92			1	1	1	2	2		1		1	1	1					2	1			1				15	20.0
88				1	1			1		1						1					1					6	8.0
84							1	1	1	2	1					1							1	1		9	12.0
80				1	1	1	1		1			1														6	8.0
76					1	1														1						3	4.0
72			1							1		2			1	1	1									7	9.3
68																		1							1	2	2.6
64												1		1						1						3	4.0
60					1		1				1															3	4.0
56						1																				1	1.3
48																1										1	1.3
32							1																			1	1.3
28										1																1	1.3
Total	2	1	4	5	6	7	6	2	3	7	4	5	1	4	1	4	1	3	1	2	1	2	1	1	1	75	99.7

Score

Range 28 to 100 Per Cent
Median 84 Per Cent
Mean 82.8 Per Cent
Per Cent of Hundreds 12

Time (74 Pupils)

Range 3 to 22.5 Minutes
Median 10 Minutes
Mean 10.1 Minutes
Standard 12 Minutes
(Preferably 5 Minutes)

TABLE XIV. Distribution of Scores Relative to Time for All Sixth Grades on Wilson S. P. Test. -- Initial Test.

Time in Minutes

Score	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	13½	14	18	21	No Time	Total	Per Cent
100	1	1				1	1	3	1	1	2		1												12	16.0
96			1	1			1	1	2	1	1	1			2				1				1		13	17.3
92			1	1	2	2	2	2	5		1		1	1		1									17	22.6
88				1							1									1					3	4.0
84				1		1			3						3							1			9	12.0
80				1					1			2													4	5.3
76											1			1	1			1							4	5.3
72													1												1	1.3
68											1			2											3	4.0
64								1																1	2	2.7
60									1																1	1.3
56																										
52																	1	1							2	2.7
48																										
44				1																					1	1.3
36																										
32														1											1	1.3
16																	1								1	1.3
12									1																1	1.3
Total	1	3	6	3	5	7	14	2	7	3	3	5	6	1	2	2	1	1		1	1	1	1		75	99.7

Score

Range 12 to 100 Per Cent
Median 92 Per Cent
Mean 84.4 Per Cent
Per Cent of Hundreds 16.0

Time (74 Pupils)

Range 3.5 to 21 Minutes
Median 7 Minutes
Mean 8 Minutes
Standard 12 Minutes
(Preferably 5 Minutes)

minutes, preferably 7 minutes.

The results for all sixth grade of the initial testing in multiplication are shown in Table XV.

D Seventh Grades

1. Addition Process Test (A. P. Test)

The scores on the A.P.Test for all seventh grades ranged from 60 per cent to 100 per cent, with a median of 94 per cent and a mean of 88.9 per cent. Eighteen pupils, or 32.1 per cent of the seventh grade group, achieved the desired goal, 100 per cent.

The time ranged from 5 minutes to 23 minutes, with a median of 8.7 minutes and a mean of 10.2 minutes. The standard for seventh grade is 12 minutes, preferably 5 minutes.

The results of the initial testing in addition for all the seventh grades are shown in Table XVI.

2. Subtraction Process Test (S. P. Test)

The scores on the S.P.Test for all seventh grades ranged from 16 per cent to 100 per cent, with a median of 94 per cent and a mean of 87.9 per cent. Sixteen pupils, or 28.5 per cent of the seventh grade group, achieved the desired goal, 100 per cent.

The time ranged from 4 minutes to 16.5 minutes, with a median of 6.25 minutes and a mean of 6.8 minutes. The standard for the seventh grade is 10 minutes, preferably 5 minutes.

The results of the initial testing in subtraction for all seventh grades

TABLE XV. Distribution of Scores Relative to Time for All Sixth Grades in the Wilson M. P. Test. -- Initial Test.

Time in Minutes

Score	4	5	6	7	8	8	9	10	10	11	11	12	12	13	13	14	14	15	15
96							1	1		1						1			
92	1	1						1	2			2				1			
88								1		1		1		2	1			1	1
84			1			1	1		1	2	1	1	1	1			1		
80								1			1		1	1	1		1		
76					2						1		1						
72								2		1		2	1	1		1		1	
68								1			1								
64				1			1				1			1					
60												1							
56								1											1
52																			
48																		1	
44																			
40																			
36										1									
32																			
28																			
12				1															
Total	1	1	1	2	2	1	3	8	3	6	5	7	4	6	2	3	2	3	2

(continued on next page)

TABLE XV. (concluded)

Score	16	17	18	18½	19	19½	22½	23	24	No Time	Total	Per Cent
96	1										5	6.6
92											8	10.6
88							1				9	12.0
84				1							12	16.0
80			1								7	9.3
76					1						5	6.7
72											9	12.0
68		1				1					4	5.3
64		1									5	6.7
60					1					1	3	4.0
56											2	2.7
52												
48											1	1.3
44												
40												
36											1	1.3
32				1							1	1.3
28								1	1		2	2.7
12											1	1.3
Total	1	2	1	2	2	1	1	1	1	1	75	99.8

<u>Score</u>

Range 12 to 96 Per Cent
Median 80 Per Cent
Mean 75.6 Per Cent
Per Cent of Hundreds 0

<u>Time</u> (74 Pupils)

Range 4.5 to 24 Minutes
Median 12 Minutes
Mean 12.6 Minutes
Standard 15 Minutes
(Preferably 7 Minutes)

TABLE XVI. Distribution of Scores Relative to Time for All Seventh Grades on Wilson A. P. Test. -- Initial Test.

Time in Minutes

Score	5	6	6½	7	7½	8	8½	9	10	10½	11	11½	12	13	14	16	16½	17	17½	18	18½	19	23	Total	Per Cent
100	1	1		6	1	3	1	1	3					1										18	32.1
96				2	1	1			1		1	2			1		1							10	17.9
92			1	2					1			1				1		1						7	12.5
88															1						1			2	3.5
84				1	1	1							1											4	7.1
80					1	1					1													3	5.3
76		1																		1		1		3	5.3
72						1				1			1											3	5.3
68														1		1								2	3.5
64																							1	1	1.7
60							1		1		1													3	5.3
Total	1	2	1	11	4	7	2	1	6	1	3	3	2	2	2	2	1	1	1	1	1	1	1	56	99.5

Scores

Range 60 to 100 Per Cent
Median 94 Per Cent
Mean 88.9 Per Cent
Per Cent of Hundreds 32.1

Times

Range 5 to 23 Minutes
Median 8.7 Minutes
Mean 10.2 Minutes
Standard 12 Minutes
(Preferably 5 Minutes)

are shown in Table XVII.

3. Multiplication Process Test (M. P. Test)

The scores on the M.P.Test for all seventh grades ranged from 28 per cent to 100 per cent, with a median of 80 per cent and a mean of 78.8 per cent. One pupil, or 1.8 per cent of group, achieved the desired goal, 100 per cent.

The time ranged from 6.5 minutes to 25 minutes with a median of 10.2 minutes and a mean of 11.3 minutes. The standard for the seventh grade is 12 minutes, preferably 6 minutes.

The results of the initial testing for all seventh grades in multiplication are shown in Table XVII.

E Eighth Grades

1. Addition Process Test (M. P. Test)

The scores on the A.P.Test for all eighth grades ranged from 40 per cent to 100 per cent, with a median of 92 per cent and a mean of 88.6 per cent. Thirteen pupils, or 22 per cent of the eighth grade group, achieved the desired goal, 100 per cent.

The time for the 57 pupils ranged from 5 minutes to 20 minutes, with a median of 8.5 minutes and a mean of 9 minutes. Two pupils failed to record their time. The standard for the eighth grade is 12 minutes, preferably 4 minutes.

The results of the initial testing in addition for all eighth grades are shown in Table XIX.

2. Subtraction Process Test (S. P. Test)

The scores on the S.P.Test for all

TABLE XVII. Distribution of Scores Relative to Time for All Seventh Grades on the Wilson S. P. Test. -- Initial Test.

Time in Minutes

Score	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	12	13½	16½	Total	Per Cent
100	2	3	4	1	1		3	1			1								16	28.5
96		1	2	4		2	1		1					1					12	21.4
92	1		2				1				1		1			1			7	12.5
88			2	1	1	1	1												6	10.8
84							2											1	3	5.3
80				1											1				2	3.5
76	1			1					1										3	5.3
72																				
68								1											1	1.7
64																	1		1	1.7
60										1		2							3	5.3
32											1								1	1.7
16									1										1	1.7
Total	4	4	10	8	2	3	8	2	3	1	3	2	1	1	1	1	1	1	56	99.4

Score

Range 16 to 100 Per Cent
Median 94 Per Cent
Mean 87.9 Per Cent
Per Cent of Hundreds 28.5

Time

Range 4 to 16.5 Minutes
Median 6.25 Minutes
Mean 6.8 Minutes
Standard 10 Minutes
(Preferably 5 Minutes)

TABLE XVIII. Distribution of Scores Relative to Time for All Seventh Grades on the Wilson M. P. Test. Initial Test.

Time in Minutes

Score	6	7	8	8½	9	9½	10	10½	11	11½	12	12½	13	14	14½	15	16	24	24½	25	Total	Per Cent
100	1																				1	1.8
96		2					1			2											5	9.2
92														1						1	2	3.6
88			1				2		3									1			7	12.8
84					1	1		1		1		1									5	9.2
80		1	1	1	1		1		1		2	1				1					10	18.4
76		2						1			1			1							5	9.2
72			1		1		1	1						1							5	9.2
68			1	1		1		1			1		1								6	11.1
64								1								1	1		1		4	7.4
60						1															1	1.8
56							1														1	1.8
48															1						1	1.8
28											1										1	1.8
Total	1	5	4	2	3	3	6	5	4	3	5	2	1	3	1	2	1	1	1	1	54	99.1

Score

Range 28 to 100 Per Cent
Median 80 Per Cent
Mean 78.8 Per Cent
Per Cent of Hundreds 1.8

Time

Range 6.5 to 25 Minutes
Median 10.2 Minutes
Mean 11.3 Minutes
Standard 12 Minutes
(Preferably 6 Minutes)

TABLE XIX. Distribution of Scores Relative to Time for All Eighth Grades on the Wilson A. P. Test. Initial Test.

Time in Minutes

Score	5	6	6½	7	7½	8	8½	9½	10	10½	11	11½	13½	14	15	20	No Time	Total	Per Cent
100	2	2	2	1	2	1			1	1	1							13	22.0
96	1	2	2		3		3			1	2							14	23.7
92	1			1	2	1			2			3	1				1	12	20.3
88			1									1			1	1		4	6.7
84				1			2											3	5.0
80								1	1									2	3.3
76						1			1									2	3.3
72						1									1			2	3.3
68				1								1			1		1	4	6.7
64														1				1	1.6
56										1								1	1.6
40									1									1	1.6
Total	4	4	5	4	7	4	5	1	6	3	3	5	1	1	3	1	2	59	99.1

Score

Range 40 to 100 Per Cent
Median 92 Per Cent
Mean 88.6 Per Cent
Per Cent of Hundreds 21.4

Time (57 Pupils)

Range 5 to 20 Minutes
Median 8.5 Minutes
Mean 9.0 Minutes
Standard 12 Minutes
(Preferably 4 Minutes)

eighth grades ranged from 56 per cent to 100 per cent, with a median of 96 per cent and a mean of 91.6 per cent. Twenty-one pupils, or 35 per cent of the eighth grade group, achieved 100 per cent accuracy.

The time ranged from 3 minutes to 13 minutes, with a median of 5.5 minutes and a mean of 6.2 minutes. One pupil failed to record his time. The standard for the eighth grade is 10 minutes, preferably 4 minutes.

The results of the initial testing in subtraction for all eighth grades are shown in Table XX.

3. Multiplication Process Test (M. P. Test)

The scores on the M.P.Test for all eighth grades ranged from 24 per cent to 100 per cent, with a median of 88 per cent and a mean of 84.2 per cent. Eight pupils, or 13.3 per cent of the group, achieved the desired goal, 100 per cent.

The time ranged from 5 minutes to 20 minutes, with a median of 9 minutes and a mean of 9.6 minutes. The standard for eighth grade is 12 minutes, preferably 8 minutes.

The results of the initial testing in multiplication for all eighth grades are shown in Table XXI.

TABLE XX. Distribution of Scores Relative to Time for All Eighth Grades on the Wilson S. P. Test. - Initial Test.

Time in Minutes

Score	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	13	No Time	Total	Per Cent
100	1	1	6		2	3		2		2	2		1			1			21	35.0
96			2	2	4			3						1					13	21.6
92					2	2					1								5	8.3
88					1	1		2											4	6.6
84					2		3		2			1	1						9	15.0
80										1							1		2	3.3
76															1				1	1.6
72									2										2	3.3
68												1						1	2	3.3
56																1			1	1.6
Total	1	1	8	2	11	6	3	7	5	3	3	2	2	1	1	2	1	1	60	99.6

Score

Range 56 to 100 Per Cent
Median 96 Per Cent
Mean 91.6 Per Cent
Per Cent of Hundreds 35.0

Time (59 pupils)

Range 3 to 13 Minutes
Median 5.5 Minutes
Mean 6.2 Minutes
Standard 10 Minutes
(Preferably 4 Minutes)

TABLE XXI. Distribution of Scores Relative to Time for All Eighth Grades on the Wilson M. P. Test. Initial Test.

Time in Minutes

Score	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	14	15	15½	16	20	Total	Per Cent
100		1	1	1				1	1			1		1	1								8	13.3
96			1	1		2	2				1	1				1			1				10	16.6
92			3	3			2		1	1	1												11	18.3
88	1			1	2		1				1	1	2										9	15.0
84										1			1										2	3.3
80						1		1							1			1				1	5	8.3
76			1											1									2	3.3
72			1														2				1		4	6.6
68														1									1	1.6
64								1	1									1					3	5.0
56									1											1			2	3.3
44																			1				1	1.6
40																		1					1	1.6
24																		1					1	1.6
Total	1	1	7	6	2	3	5	3	4	2	3	3	3	3	2	1	2	4	2	1	1	1	60	99.4

Score

Range 24 to 100 Per Cent
Median 88 Per Cent
Mean 84.2 Per Cent
Per Cent of Hundreds 13.3

Time

Range 5 to 20 Minutes
Median 9 Minutes
Mean 9.6 Minutes
Standard 12 Minutes
(Preferably 6 Minutes)

Following is Table XXII which shows on a percentage basis the distribution of scores for all grades and processes in the Wilson Inventory and Diagnostic Tests in the initial testing, in December. At the left in the summary table will be found the scores arranged in descending order from 100 per cent to 0 per cent. Beside each score, reading across the paper from left to right, will be found the per cent of children in all grades receiving that score on two or three tests. At almost a glance a comparison can be made of the distribution of scores on a percentage basis for all grades and all processes in the initial testing.

In order to compare the results in the addition, subtraction, and multiplication processes in the different grades as well as in the various schools Table XXIII has been prepared. At the left will be found the name of the schools with the grade distribution. Opposite each grade will be found the number of pupils in it, together with the mean score, the per cent of hundreds and the mean time for each process in which the pupils were tested. Below will be found the total or the average data for the same items. Thus one reads that the fourth grade in addition in the Fletcher School achieved a mean score of 66.6 per cent, that no one had 100 per cent, and that the mean time was 14.5 minutes. Below that one reads that the total enrollment of the school is 14 pupils and that they

TABLE XXII. Distribution of Scores on a Percentage Basis for All Grades and Processes in the Initial Testing. - Wilson Inventory and Diagnostic Tests.

Score	Grade IV Number of Pupils 57 A. P.	59 S. P.	Grade V Number of Pupils 62 A.P.	63 S.P.	56 M.P.	Grade VI Number of Pupils 75 A.P.	75 S.P.	75 M.P.
100	3.5	12.0	6.4	4.7	1.7	12.0	16.0	
96	5.2		16.1	14.2	8.9	10.6	17.3	6.6
92	5.2	12.0	6.4	11.1	5.3	20.0	22.6	10.6
88	10.5	12.0	8.0	6.3	5.3	8.0	4.0	12.0
84	12.2	5.0	16.1	12.7	5.3	12.0	12.0	16.0
80	8.7	3.4	6.4	4.7	21.4	8.0	5.3	9.3
76	10.5		11.3	7.2	14.2	4.0	5.3	6.7
72	12.2	5.0	4.8	6.3	3.5	9.3	1.3	12.0
68	10.5		6.4	7.9	1.7	2.6	4.0	5.3
64	1.7	10.1	4.8	3.1	7.1	4.0	2.7	6.7
60	5.2	3.4	3.2		1.7	4.0	1.3	4.0
56	3.5	1.7	6.4	3.1	10.7	1.3		2.7
52	3.5		1.6	1.6	3.5		2.7	
48		1.7	1.6	1.6	3.5	1.3		1.3
44		3.4		1.6			1.3	
40	3.5	3.4		3.1				
36	3.5	1.7		3.1				1.3
32		3.4		1.6	3.5	1.3	1.3	1.3
28		1.7			1.7	1.3		2.7
24		1.7						
20		5.0		1.6				
16		1.7					1.3	
12		3.4		1.6			1.3	1.3
8		3.4		1.6				
4		1.7						
0		3.4						
Total	99.4	99.2	99.5	99.4	99.0	99.7	99.7	99.8

(continued on next page)

TABLE XXII. (concluded)

Score	Grade VII Number of Pupils 56 A.P.	56 S.P.	54 M.P.	Grade VIII Number of Pupils 59 A.P.	60 S.P.	60 M.P.
100	32.1	28.5	1.8	22.0	35.0	13.3
96	17.9	21.4	9.2	23.7	21.6	16.6
92	12.5	12.5	3.6	20.3	8.3	18.3
88	3.5	10.8	12.8	6.7	6.6	15.0
84	7.1	5.3	9.2	5.0	15.0	3.3
80	5.3	3.5	18.4	3.3	3.3	8.3
76	5.3	5.3	9.2	3.3	1.6	3.3
72	5.3		9.2	3.3	3.3	6.6
68	3.5	1.7	11.1	0.7	3.3	1.6
64	1.7	1.7	7.4	1.6		5.0
60	5.3	5.3	1.8			
56			1.8	1.6	1.6	3.3
52						
48			1.8			
44						1.6
40				1.6		1.6
36						
32		3.5				
28			1.8			
24						1.6
20						
16		1.7				
12						
8						
4						
0						
Total	99.5	99.4	99.0	99.1	99.6	99.8

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TABLE XXIII. Comparative Results of the Wilson Inventory and Diagnostic Tests in A.P., S.P., and the M.P. for the Various Schools and Grades Expressed in Per Cent.

School	No. in Grade	Addition Mean Score	Addition Per Cent of Hundreds	Addition Mean Time	Subtraction Mean Score	Subtraction Per Cent of Hundreds	Subtraction Mean Time	Multiplication Mean Score	Multiplication Per Cent of Hundreds	Multiplication Mean Time
Fletcher One-room										
Grade IV	3	66.6	0	14.5	44.0	0	10.5			
V	2	72.0	0	6.7	86.0	0	5.2	72.0	0	12.0
VI	5	88.0	0	10.4	89.6	0	7.2	78.4	0	13.2
VII	2	100.0	100	6.0	94.0	50.	5.5	84.0	0	9.1
VIII	2	94.0	0	5.7	92.0	0	4.6	78.6	0	10.2
Total or Average	14	84.1	13	8.6	81.0	6.6	6.8	77.6	0	10.5
Red Village One-room										
Grade IV	1	72.0	0	17.0	92.0	0	21.0			
V	3	64.0	0	17.0	68.0	0	12.8	65.3	0	24.7
VI	4	65.0	0	8.8	71.0	0	8.5	58.0	0	13.1
VII	1	92.0	0	16.0	96.0	0	5.5	80.0	0	9.0
Total or Average	9	68.4	0	13.8	75.1	0	11.0	63.5	0	13.0
East Burke Two-room										
Grade IV	7	53.7	0	19.2	35.4	0	11.5			
V	2	84.0	0	12.0	74.0	0	8.0	62.0	0	18.0
VI	8	74.0	12.5	12.0	67.5	0	9.5	62.0	0	14.7
VII	8	82.0	12.5	12.7	82.0	12.5	8.1	72.0	0	14.0
VIII	3	74.6	0	12.5	78.6	0	9.0	68.0	33.3	11.6
Total or Average	28	72.0	7.1	14.0	55.3	3.5	10.1	66.6	4.7	14.3

(continued on next page)

TABLE XXIII. (continued)

School	No. in Grade	Addition			Subtraction			Multiplication		
		Mean Score	Per Cent of Hundreds	Mean Time	Mean Score	Per Cent of Hundreds	Mean Time	Mean Score	Per Cent of Hundreds	Mean Time
Sheffield Two-room										
Grades IV	6	76.0	0	14.6	51.0	16.6	9.0			
V	5	83.2	0	12.0	62.6	0	10.8	58.0	0	12.1
VI	5	95.2	40.0	7.7	85.0	25.0	5.1	85.3	0	9.6
VII	3	94.6	33.3	8.5	98.6	66.6	6.0	86.0	0	11.7
VIII	4	94.0	50.0	7.4	94.0	50.0	5.6	85.0	0	9.1
Total or Average	23	87.1	21.7	10.4	66.3	26.0	8.1	78.5	0	10.7
Wheelock Two-room										
Grade V	3	73.3	0	13.3	56.0	0	10.1	74.6	0	17.8
VI	5	80.0	0	11.6	82.4	0	7.1	78.4	0	13.8
VII	3	84.0	33.3	9.0	96.0	66.6	5.1	80.0	33.3	9.5
VIII	6	91.3	16.2	9.8	94.6	50.0	5.5	90.0	33.3	10.5
Total or Average	17	83.5	11.8	10.8	84.8	29.4	7.26	82.1	17.6	12.6
Lyndon Three-room										
Grade IV	11	82.5	0	16.0	65.0	0	11.6			
V	18	83.3	11.1	11.8	79.7	11.1	8.9	75.5	0	16.1
VI	12	78.1	9.0	11.5	88.6	25.0	6.5	77.0	0	12.2
VII	7	93.1	42.8	8.3	90.8	55.5	5.0	81.1	0	9.0
VIII	10	89.7	33.3	7.7	91.6	40.0	5.5	89.6	30.0	9.4
Total or Average	58	85.3	15.5	11.0	82.2	22.4	8.0	78.9	5.1	13.3

(continued on next page)

TABLE XXIII. (concluded)

School	No. in Grade	Addition			Subtraction			Multiplication		
		Mean Score	Per Cent of Hundreds	Mean Time	Mean Score	Per Cent of Hundreds	Mean Time	Mean Score	Per Cent of Hundreds	Mean Time
Lyndon Center Four-room										
Grades IV	9	72.7	0	15.9	49.7	0	8.9			
V	5	68.8	0	9.7	57.6	0	10.0	44.0	0	17.0
VI	14	73.4	0	9.9	85.7	21.4	8.7	72.0	0	13.5
VII	10	74.8	10	11.5	78.0	10.0	8.5	70.8	0	12.5
VIII	14	82.5	7.1	9.4	91.4	35.7	6.2	77.1	7.1	10.5
Total or Average	52	74.3	3.8	11.9	71.2	1.7	8.4	70.0	2.3	12.8
Lyndonville Eight-room										
Grades IV	22	70.9	9.0	14.5	73.0	27.2	14.8			
V	24	84.0	8.3	8.5	77.8	4.1	7.5	76.5	4.5	9.5
VI	23	88.1	21.7	9.5	88.6	21.7	8.0	81.0	0	12.1
VII	22	94.7	36.3	9.8	90.1	22.7	6.7	80.3	0	11.2
VIII	21	92.6	28.5	9.4	92.3	42.8	6.2	87.8	5.0	9.0
Total or Average	112	86.0	20.7	10.3	85.3	25.7	8.6	81.4	2.3	10.4

achieved an average mean score of 84.1 per cent in addition, that 13 per cent had perfect scores, and that the average mean time was 8.6 minutes.

From the initial testing one notes the wide range of scores made on the tests even in grades six to eight-the grades in which one expects to find a greater degree of perfectness. Almost every grade group revealed a median score and a mean score higher than 70 per cent which is known in most schools as the passing grade. In spite of this only 46 pupils, or 11.0 per cent out of 307 pupils received perfect scores in the A. P. Test; 58 pupils, or 12.1 per cent out of 313 pupils, received perfect scores in the S. P. Test. Only 10 pupils, or 4 per cent out of 245 pupils who took the M. P. Test, had perfect scores. The highest percentage of pupils achieving 100 per cent accuracy in any one grade group in the A.P. Test was 32.1 per cent, or 18 pupils out of 56 in the seventh grade group; in the S. P. Test 35 per cent, or 21 pupils out of 60 in the eighth grade group; in the M. P. Test 13.3 per cent, or 8 pupils out of 60 in the eighth grade group.

Against this, only the fourth grade group in the S. P. Test shows a median score or a mean score below the passing grade of 70 per cent(see Table IX). From the data in Table XXIII one sees several individual grades in their mean score falling below the usual passing grade of 70 per cent.

Wilson says, "A general average of 75 per cent or 80 per cent for a class in a single process in addition means that over three fourths of the class have made mistakes and this is not satisfactory from any angle."1/

Wilson also says, "The only right standard for drill is the 100 per cent standard and this is easily possible in arithmetic because the processes calling for drill are few."2/

This view is also supported by other good authorities; for example, Hawkes, Lindquist, and Mann say,

> "If there were available for a given course a detailed description of the specific elements of achievement which individually and collectively are considered essential to promotion, and if each, or if a random sample, of these elements could be measured by separate test items, then a 'passing grade' could be meaningfully described, but in this case it would be at or near 100 per cent, and not at 60, 70, or 75 per cent. That is, a pupil would deserve promotion only if he had mastered all of the minimum essentials for promotion."3/

The wide range in time is not of particular concern

1/ G. M. Wilson, M. B. Stone, and others, op. cit., p. 94.

2/ G. M. Wilson, "The Corrective Load in the Fundaments of Arithmetic in Grades VI., VII., and VIII." Official Report of the American Education Research Association, New Orleans, pp. 234-241, 1937.

3/ Hawkes, Lindquist, and Mann, The Construction and Use of Achievement Examinations, p. 36.

(since individual variation must be allowed for without pressure) were it not for the fact that over 50 per cent of the pupils exceed a very generous time allowance. Obviously they are not secure in their learning of basic facts in the fundamental processes.

5. Further Testing:-- The tests already given showed plenty of work to do. They were used to analyze the weaknesses of individual pupils and the results made the basis of a remedial program as will be explained in the next chapter. To supplement the results, however, a second test was used, namely, the Monroe Standardized General Survey Arithmetic Scales-Scale 1, Form 1 for Grades III, IV, and V. Frequently teachers feel that a second opportunity, or even a greater number of opportunities, should be given to show achievement. All writers who have gone into remedial teaching, realize that testing must be a continuous process.

Breuckner says,

> "It is, therefore, very difficult to get a satisfactory measure of a pupil's ability by a single test given under a certain set of conditions, since under other conditions the results may be quite different. Ratings of pupils whose scores are equal on a test given under one set of conditions offen differ considerably when the test is given under slightly different conditions."1/

1/ L. J. Breuckner, "Persistency of Errors as a Factor in Diagnosis." Education, 56: pp. 140-144, (November 1935).

The Monroe scales were helpful in that they gave another view of the children's accomplishments. They showed the grade equivalent for each child as well as the grade median.

Table XXIV shows the comparative results of the Monroe Scales, Form 1 for Grades III, IV, and V* for the various schools and grades. In each form, each process has two tests. In scoring the tests, in each process, the sum of the results in the two tests was found and translated into terms of per cent. The time, 2.25 minutes, was the time allowed for the administration of both tests in a single process. The Table is read as follows. At the left are the names of the schools with the number of pupils in each; at the top across the paper are the different processes with the mean scores in per cent. Thus one reads that the fourth grade in the Fletcher School has three pupils and that their mean score in per cent was 29.9 per cent in addition and 36.5 per cent in subtraction. No pupil received a perfect score as the time limits precluded the 100 per cent goal. The mean score in per cent for any grade and any school in any of the three processes may be seen in Table XXIV.

By comparing the results shown in Table XXIV with those in Table XXIII one sees that the results of the Monroe scales are lower. This is probably due in large measure to the time

* Copies of the Monroe scales are to be found at the end of the study.

TABLE XXIV. Comparative Results of the Monroe Scales, Form 1 for Grades III, IV, and V for the Various Schools and Grades in Addition, Subtraction, and Multiplication.

Time for Tests in Each Process -- 2.25 Minutes

School and Grades	Number of Pupils	Addition		Subtraction		Multiplication	
		Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds
Fletcher							
Grade IV	3	29.0		36.5			
V	2	53.1		68.3		57.8	
VI	5	45.9		63.6		41.1	
VII	1	83.5		72.5		65.0	
VIII	2	49.4		74.8		76.4	
Total or Average	14	52.3	None	62.2	None	50.3	None
Red Village							
Grade IV	1	35.0		19.5			
V	3	48.4		42.6		28.5	
VI	4	64.6		63.0		33.9	
VII	1	78.3		58.5		34.2	
Total or Average	9	57.5	None	39.1	None	31.8	None
East Burke							
Grade IV	7	20.9		19.1			
V	2	34.5		54.2		26.4	
VI	8	40.7		45.8		41.5	
VII	8	38.6		46.4		42.4	
VIII	3	47.4		58.5		49.4	
Total or Average	28	36.4	None	41.5	None	41.5	None

(continued on next page)

TABLE XXIV. (continued)

Time for Tests in Each Process -- 2.35 Minutes

School and Grades	Number of Pupils	Addition		Subtraction		Multiplication	
		Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds
Sheffield							
Grade IV	5	26.4		29.6			
V	4	35.5		30.2		35.1	
VI	5	42.2		44.1		40.5	
VII	3	49.8		45.1		40.0	
VIII	4	54.8		52.4		52.8	
Total or Average	21	41.7	None	38.3	None	41.7	None
Wheelock							
Grade V	3	34.6		32.4		26.5	
VI	5	40.2		51.2		47.4	
VII	3	53.6		68.6		56.5	
VIII	6	44.8		54.0		44.2	
Total or Average	17	43.3	None	51.5	None	47.6	None
Lyndon							
Grade IV	11	38.7		41.8			
V	18	46.9		50.6		51.1	
IV	12	46.6		46.7		44.7	
VII	7	60.6		68.0		57.1	
VIII	10	63.9		71.2		59.5	
Total or Average	58	49.8	None	53.6	None	42.2	None

(continued on next page)

TABLE XXIV. (concluded)

School and Grades	Number of Pupils	Time for Tests in Each Process -- 2.25 Minutes					
		Addition		Subtraction		Multiplication	
		Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds	Mean Score in Per Cent	Per Cent of Hundreds
Lyndon Center							
Grades IV	9	23.0		38.5			
V	5	35.8		41.4		35.7	
VI	14	40.2		46.1		45.1	
VII	10	42.0		40.9		35.8	
VIII	14	46.6		45.8		38.7	
Total or Average	52	37.5	None	42.5	None	38.8	None
Lyndonville							
Grades IV	21	27.1					
V	20	37.9		50.5		36.7	
VI	21	46.2		52.0		43.5	
VII	22	51.0		52.8		49.5	
VIII	18	36.6		55.5		53.2	
Total or Average	102	39.7	None	52.7	None	45.7	None

element which was not present in the administration of the Wilson Tests.

The results of the Monroe scale substantiated the results of the Wilson tests and revealed the need of a remedial program. From the preliminary testings, a diagnosis of each child's weaknesses was made and a remedial program adapted to the needs of the individual, as well as the group, was set up by each teacher. The work was confined to one process since the practice period was to continue for only six weeks before the retesting. The Lyndonville Graded School, with the exception of the fourth grade, worked upon multiplication; that grade with all grades (four through eight) in the other schools took the addition process.

1/ W. J. Osburn, Corrective Arithmetic, p. 60.

CHAPTER III

THE REMEDIAL PROGRAM

1. Types of Errors:- The fact that all classes used in this study were in need of remedial work is quite evident from the preceding section. The first step after the papers were corrected was to list the errors that existed in each of the three fundamental processes. This could be more complete only as the teacher worked with her own group, for not all errors are evident as one studies the test papers alone. Since the writer did not work with the children no attempt has been made to obtain a complete list of errors. Summary sheets covering all tests for all grades and schools were made and these show to a limited extent the type of errors made by each pupil. A sample sheet is shown for Grade IV in Exhibit A. Thus one reads that Pupil A had a score of 72 and did his test in 21.5 minutes and missed seven examples-the 15th, and the 20th through the 25th. By looking at those examples one may read something of the nature of the errors; at least one can see what types of examples cause the most trouble. Exhibits B, C, and D show some of the common errors which can readily be seen from the test papers. With some of the

Exhibit A -- Teacher's Summary for the Wilson Addition Process Test in the Initial Testing. -- Fourth Grades

Pupil	Score	Time in Min.	ERRORS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Number of Errors
A	72	21[2]															✓					✓	✓	✓	✓	✓	✓	7
B	60	14			✓												✓		✓		✓	✓	✓	✓	✓	✓	✓	10
C	68	8																	✓		✓	✓	✓	✓	✓	✓	✓	8
D	72	17																✓		✓	✓		✓	✓		✓	✓	7
E	88	14[2]															✓							✓		✓		3
F	76	12																		✓	✓		✓		✓	✓	✓	6
G	56	17	✓			✓		✓		✓									✓	✓			✓	✓	✓	✓	✓	11
H	84	14	✓														✓					✓	✓					4
I	68	16						✓								✓	✓		✓			✓		✓		✓	✓	8
J	80	11[2]								✓								✓	✓	✓					✓			5
K	84	8																		✓		✓				✓	✓	4
L	68	15																✓		✓	✓		✓	✓	✓	✓	✓	8
M	84	25																	✓						✓	✓	✓	4
N	92	8																					✓			✓		2
O	76	15			✓														✓				✓	✓	✓	✓		6
P	84	20																✓			✓			✓			✓	4
Q	92	14																						✓		✓		2
R	88	19																			✓		✓			✓		3
S	80	14													✓						✓		✓	✓		✓		5
T	84	18																						✓	✓	✓	✓	4
U	76	20		✓					✓						✓		✓		✓							✓		6
V	80	10[2]																			✓		✓	✓		✓	✓	5
W	72	17[2]												✓		✓	✓	✓						✓		✓	✓	7
X	72	9[2]													✓							✓	✓	✓	✓	✓	✓	7
Y	56	21[2]					✓										✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	11
Z	72	14[2]														✓		✓			✓		✓	✓		✓	✓	7
AA	68	16[2]	✓																	✓		✓	✓	✓	✓	✓	✓	8
BB	72	27[2]													✓				✓	✓			✓	✓		✓	✓	7

(continued on next page)

Exhibit A -- (continued)

Pupil	Score	Time in Min	ERRORS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Number of Errors
CC	88	9[2]	✓														✓									✓		3
DD	64	16[2]					✓					✓		✓		✓			✓				✓	✓	✓	✓		9
EE	72	12[2]	✓				✓	✓									✓							✓		✓	✓	7
FF	68	14[2]	✓														✓		✓				✓	✓	✓	✓	✓	8
GG	80	14[2]																		✓				✓	✓	✓	✓	5
HH	76	17[2]																	✓	✓		✓	✓	✓		✓		6
II	88	9																✓	✓							✓		3
JJ	100	10																										0
KK	96	10[2]																	✓									1
LL	60	--												✓				✓		✓	✓	✓	✓	✓	✓	✓	✓	10
MM	92	8																								✓	✓	2
NN	96	15																								✓		1
OO	68	26					✓											✓	✓		✓			✓	✓	✓	✓	8
PP	40	15[2]		✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
QQ	88	17[2]																						✓		✓	✓	3
RR	84	13						✓											✓		✓					✓		4
SS	80	16[2]																	✓	✓				✓		✓	✓	5
TT	96	12[2]																						✓				1
UU	84	17[2]																	✓						✓	✓	✓	4
VV	60	10	✓	✓													✓			✓	✓		✓	✓	✓	✓	✓	10
WW	100	14[2]																										0
XX	88	16																	✓	✓						✓		3
YY	68	17																✓		✓		✓	✓	✓	✓	✓	✓	8
ZZ	76	18[2]															✓	✓	✓				✓	✓		✓		6
AAA	76	8																✓		✓	✓			✓		✓	✓	6
BBB	44	22	✓		✓									✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		14
CCC	44	19												✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	14
DDD	52	21			✓										✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	12
EEE	52	21												✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	12

(continued on next page)

Exhibit A -- (concluded)

Pupil	Score	Time in Min.	ERRORS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Number of Errors
FFF	68	17															✓	✓	✓			✓		✓	✓	✓	✓	8
GGG	40	27								✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15
Total No. of Errors			8	3	4	1	4	4	1	3	1	1	0	8	8	10	20	19	28	23	20	17	31	41	28	52	37	372

Total number of pupils -- 59

errors noted, the test papers with a form similar to Exhibit A were given to the room teachers.

Exhibit B -- Errors in Addition

Types of Errors

1. Incorrect primary facts
2. Use of crutches
3. Forgetting to carry
4. Counting
5. Carrying wrong number
6. Getting lost in column work
7. Decimal point
8. Trouble with zero facts
9. Subtracts rather than adds
10. Incorrect upper decade facts
11. Multiplies rather than adds
12. Omission of examples
13. Numbers written in reverse

2. Causes and Correction of Errors:- If a teacher is to eliminate failures from her class she must recognize the general causes which may bring about such an unsatisfactory condition. Yarbrough in her study of remedial work has briefly summarized them as follows:

"(1) Physical causes, (2) systematic drill

> in arithmetic is started before child is ready for it, (3) the teacher often has no systematic plan for teaching the fundamental processes, (4) children are pushed ahead too rapidly, (5) drill is carried on ineffectively, (6) the drill load is too heavy, and (7) teachers are failing to recognize, diagnose, and correct errors found in the work of their pupils as soon as they appear."1/

Not only must the teacher know the causes of the weaknesses but she must know the corrective measures for each specific weakness. For example, one of the common errors revealed on the test papers was that of counting. (See Exhibits B, C, and D) What are the causes of and the corrective measures for counting?

Myers says,

> "Many writers of methods develop methods and teaching exercises which make the habit of counting in number learning inevitable. The first step in current teaching of addition facts is to present those combinations which consist of one added to a larger digit, as: $\begin{array}{r} 2 \\ \underline{1} \end{array}$ $\begin{array}{r} 3 \\ \underline{1} \end{array}$, etc. Everywhere the practice is to introduce those combinations first which not only admit of counting but which are presented by a counting process. Children are taught to imagine the units of these increments. This explains why 9 and 7 is harder than 2 and 1 for the average child. The former is harder to count. The larger numbers, too, in present practice, are presented as object units, then picture units, then as image units. But what of the psychology? Take

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1/ Dorothy Yarbrough, "A Diagnosis of Pupils' Errors in Arithmetic with a View to Corrective Work Carried on Through the Cooperation of the Teachers," Unpublished Master's thesis, Boston University, 1938, pp. 108, 109.

Exhibit C -- Errors in Subtraction

Types of Errors

1. Forgetting one was borrowed
2. Incorrect primary facts
3. Counting
4. Dangling lefts ignored
5. Vanishing lefts brought down
6. Subtracting some numbers from zero
7. Zero subtracted from some numbers
8. Crutches
9. Decimal points in United States money

> these objects from his sight and he is very apt to repeat his earlier experiences of counting unit-images, by counting these objects not present. Auditory, tactful, and motor images may be employed instead of visual ones."1/

Morton says,

> "If the pupil has formed the habit of counting to find sums, this habit must be broken. It may be broken by re-teaching the facts which are not known, by showing the economy of time and the reduction in errors which accompany the giving of immediate responses, by working with the pupils individually as a means of encouraging them to give sums quickly, and by practice or drill exercises which

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1/ G. C. Myers, The Prevention and Correction of Errors in Arithmetic, Chapter II.

place some emphasis upon speed."1/

The Bureau of Reference of the Board of Education of the City of New York says,

> "(a) The pupils should have sufficient motivated drill to make the combinations automatic. Use simple concrete problems to help impress the meaning.
> (b) Use individual flash cards, wall charts, and note-books in which children record the combinations needing special study.
> (c) Tell the child the correct answer when he hesitates or does not know the combination.
> (d) Discourage the use of counting; point out the disadvantages. The pupils can learn to watch themselves and to check this habit to a great extent."2/

Buswell and John say, "Children can never be efficient in arithmetic until they abandon their erratic and wasteful habits of working."3/

And Osburn goes on to say, "The fundamental thesis of corrective arithmetic is the idea that the function of the teacher is to help the child to learn things of value in arithmetic which he is capable of learning but has not learned."4/

1/ R. L. Morton, op. cit., pp. 46, 47.

2/ Bureau of Reference, Research, and Statistics, Eugene A. Nifenecker, Director, Board of Education of the City of New York, p. 5.

3/ G. T. Buswell, and Lenore John, Diagnostic Studies in Arithmetic

4/ W. J. Osburn, op. cit., p. 100.

Exhibit D -- Errors in Multiplication

Types of Errors

1. Incorrect primary facts
2. Added rather than multiplied
3. Difficulty with zero in multiplicand
4. Carried when no need
5. Forgetting to carry
6. Incorrect primary addition facts
7. Carried wrong number
8. Omitted examples
9. Incorrect upper decade addition facts
10. Errors with zero in multiplier
11. Counting
12. Omitting one figure of multiplier
13. Omitting one figure of multiplicand
14. Decimal point in United States money

3. The Corrective Program:- The Wilson tests used in the study are, as the name implies, diagnostic in nature. When these were returned to the room teachers they made a diagnosis of each pupil's errors. The causes of errors were also located through the oral work with individuals and the class, for a test never reveals the reasons for all errors. These were listed by many of the teachers and the pupils. This cooperative work helped the children to be more conscious

of their weaknesses and for some it proved a real challenge.

With the knowledge of the weaknesses in the combinations and the processes, the program was ready to be launched. The teachers kept in mind the steps in good drill technique. These organized by Wilson are:

" 1. Interest and Motivation
2. Thorough understanding--Drill kept behind meaning
3. Organization of drill material--Deferred until need is evident to child
4. Laws of memory observed
5. Review, use, and application
Drill, as a whole, gives us a systematic review of all facts and processes, a practice to retain skills already acquired, and a general strengthening of all skills."1/

Each teacher kept the work motivated in a variety of ways. Charts of the facts as found in "My Addition Drill Book"2/ were made and used. Individual flash cards were made and used by the children in pairs and in small groups. Some children were much interested in breaking their own records. Games and game devices such as farmer, baseball, hippety hop, bean bag, ringtoss had their places in the scheme. Blackboard drill and self testing exercises had their places along with check-up tests.

The amount of time spent daily upon this work varied

1/ G. M. Wilson, "What Research Reveals on Proper Drill Content of Elementary Arithmetic?", Mathematics Teacher, 28: pp. 477-483, (August 1935).

2/ G. M. Wilson, My Addition Drill Book.

according to the age, the grade, and the needs of the pupils-most teachers used from ten to twenty minutes; only in one case did the time exceed twenty minutes.

The children continued to be interested in their progress throughout the six weeks' drill period.

CHAPTER IV

THE FINAL TESTING

1. The Testing Procedure:- In March 1942, all the children were retested in one fundamental process; namely, multiplication for grades five through eight of the Lyndonville Graded School, and addition for all other pupils in grades four through eight.

Both the Wilson process tests and the Monroe scale were used. The same instructions as used before were given for the retesting; namely, for the Wilson tests, that each pupil move forward with his work and take time to complete it; for the Monroe scale that each do what he could in a limited time as stated in the manual of directions.* From the practice work, the children were conscious of the fact they were working for accuracy within a reasonable time limit.

Each room teacher corrected her own test papers using exactly the same scoring as was used in the initial testing. The results were not rechecked as in the original testing, for those were found to be very accurate and whatever differences there were would have mattered very little either toward a higher or a lower score. The results were tabulated and arranged for a comparative study. As one reads the results of the final testing and compares them with the results

* See copy at the end of the study.

of the initial testing in Chapter II, he should keep in mind that the number of children may differ slightly and that percentages will therefore differ since not all pupils or exactly the same pupils were retested in either the addition or the multiplication process in grades five through eight.

2. The Testing Results:- All Schools Exclusive of Lyndonville Graded School, Grades V-VIII.

(a) Fourth Grades -- 57 pupils

Addition Process Test (A. P. Test)

The scores in the A. P. Test for all fourth grade pupils ranged from 36 per cent to 100 per cent, with a median of 80 per cent and a mean of 78.3 per cent. Six pupils, or 10.5 per cent of the fourth grade group, achieved the 100 per cent goal; 9 made one error each, and 2 others made two errors each.

The time ranged from 5 minutes to 40 minutes, with a median of 11 minutes and a mean of 13.5 minutes. The standard time for grade four is from 8 minutes to 15 minutes, preferably 8 minutes. (See Table XXV)

(b) Fifth Grades -- 38 pupils

Addition Process Test (A. P. Test)

The scores on the A. P. Test for all fifth grade pupils ranged from 32 per cent to 96 per cent, with a median of 84 per cent and a mean of 82.8 per cent. No pupil achieved the 100 per cent goal: 8 made one error each, and 5

others made two errors each.

The time ranged from 4 minutes to 15 minutes with a median of 9 minutes and a mean of 9.7 minutes. The standard time for grade five is from 6 minutes to 15 minutes, preferably 6 minutes. (See Table XXVI)

(c) Sixth Grades -- 52 pupils

Addition Process Test (A. P. Test)

The range of scores in the A. P. Test for all sixth grades ranged from 60 per cent to 100 per cent, with a median of 88 per cent and a mean of 76.2 per cent. Five pupils, or 9.6 per cent of the sixth grade group, reached the 100 per cent goal; 6 pupils made one error each, and 14 others made two errors each.

The time ranged from 5 minutes to 15 minutes with a median of 9 minutes and a mean of 9.1 minutes. The standard time for sixth grade is from 5 minutes to 12 minutes, preferably 5 minutes. (See Table XXVII)

(d) Seventh Grades -- 34 pupils

Addition Process Test (A. P. Test)

The scores on the A. P. Test for the seventh grades ranged from 60 per cent to 100 per cent, with a median of 92 per cent and a mean of 86.6 per cent. Two pupils, or 5.8 per cent of the fifth grade group, achieved the 100 per cent goal: 11 others made one error each, and 6 others

had two errors each.

The time ranged from 4 minutes to 17 minutes, with a median of 8.7 minutes and a mean of 8.8 minutes. The standard for seventh grades is from 5 minutes to 12 minutes, preferably 5 minutes. (See Table XXVIII)

(e) Eighth Grades -- 38 pupils

Addition Process Test (A. P. Test)

The scores in the A. P. Test for all eighth grade pupils ranged from 56 per cent to 100 per cent, the median being 92 per cent and the mean 89.9 per cent. Eight pupils, or 21 per cent of the eighth grade group, achieved the 100 per cent goal; 6 pupils made one error each, and 9 others made two errors each.

The time ranged from 4 minutes to 19 minutes with a median of 7.2 minutes and a mean of 8.3 minutes. The standard for eighth grades is from 4 minutes to 12 minutes, preferably 4 minutes. (See Table XXIX)

Lyndonville Graded School

(a) Fifth Grade -- 19 pupils

Multiplication Process Test (M. P. Test)

The scores in the M. P. Test ranged from 52 per cent to 100 per cent, with a median of 88 per cent and a mean of 86.7 per cent. Two pupils, or 10.6 per cent of the fifth grade, achieved the 100 per cent goal; 5 pupils made

TABLE XXV. Distribution of Scores Relative to Time for All Fourth Grades on the Final A. P. Test.

Time in Minutes

Score	5	6	7	7½	8	8½	9	9½	10	10½	11	11½	12	13	14½	16	16½	17	17½	18	18½	20 to 40	Total	Per Cent
100	1	1	1				1			1					1								6	10.5
96		1		1						5								1			1		9	15.8
92								1			1												2	3.5
88											1		1		1								3	5.2
84						1			1	1												1	4	7.0
80	1		2		1		1	1	1				2			1						1	11	19.3
76											1	1										1	3	5.2
72						1							1			1						1	4	7.0
68																			1			2	3	5.2
64					1			1													1	1	4	7.0
60											1			1			1						3	5.2
56																		1		1		1	3	5.2
52																						1	1	1.7
30																						1	1	1.7
Total	2	2	3	1	2	2	2	3	2	7	4	1	4	1	2	2	1	2	1	1	2	10	57	99.5

Score

Range 36 to 100 Per Cent
Median 80 Per Cent
Mean 78.3 Per Cent
Per Cent of Hundreds 10.5
Standard 100 Per Cent

Time

Range 5 to 40 Minutes
Median 11 Minutes
Mean 13.5 Minutes
Standard 15 Minutes
(Preferably 8 Minutes)

TABLE XXVI. Distribution of Scores Relative to Time for the Fifth Grades on the Final A. P. Test.

Time in Minutes

Score	4	5	6	7	7½	8	8½	9	9½	10	11	11½	12	12½	13	14½	15	Total	Per Cent
96				1	2	1			1		2	1						8	21.1
92				1		2	1	1										5	13.1
88			1	1							1							3	7.8
84	1			1			1						1	1				5	13.1
80					1	1		1		1		1			2			7	18.4
76						1			1		1							3	7.8
72			1						1							1		3	7.8
68									1								1	2	5.2
64													1					1	2.6
32		1																1	2.6
Total	1	1	2	4	3	5	2	2	4	1	4	2	2	1	2	1	1	38	99.5

Score		Time	
Range	32 to 96 Per Cent	Range	4 to 15 Minutes
Median	84 Per Cent	Median	9 Minutes
Mean	82.8 Per Cent	Mean	9.3 Minutes
Per Cent of Hundreds	0	Standard	6 to 15 Minutes
Standard	100 Per Cent		(Preferably 6 Minutes)

TABLE XXVII. Distribution of Scores Relative to Time for the Sixth Grades on the Final A. P. Test.

	Time in Minutes																		
Score	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	15	Total	Per Cent
100		1	2		1							1							5	9.6
96	1					1	1	1	1		1								6	11.5
92	1	1			1		1	1	1	1	2	1	2				1	1	14	26.9
88						1			2			1							4	7.7
84					1				1				2						4	7.7
80	1				2		1	1		1	1	1					1		9	17.3
76								1	1				1				1		4	7.7
72									1										1	1.9
68													1			1	1		2	3.8
60				1					1						1				3	5.7
Total	3	2	2	1	5	2	3	4	8	2	4	4	6		1	1	3	1	52	99.8

Score		Time	
Range	60 to 100 Per Cent	Range	5 to 15 Minutes
Median	88 Per Cent	Median	9 Minutes
Mean	76.2 Per Cent	Mean	9.1 Minutes
Per Cent of Hundreds	9.6	Standard	5 to 12 Minutes
Standard	100 Per Cent		(Preferably 5 Minutes)

TABLE XXVIII. Distribution of Scores Relative to Time for the Seventh Grades on the A. P. Test.

Time in Minutes

Score	4	4½	5	5½	6	7	8	8½	9	9½	10	10½	11	11½	14	15	17	Total	Per Cent
100				1	1													2	5.8
96			1			3				1	3		2		1			11	32.3
92			1			1	1		1				2					6	17.6
88	1		1			1					1							4	11.7
84								1			1							2	5.8
76		1								1								2	5.8
72																	1	1	2.9
68								1				1				1		3	8.8
64								1						1				2	5.8
60							1											1	2.9
Total	1	1	3	1	1	5	2	3	1	2	5	1	4	1	1	1	1	34	99.4

Score		Time	
Range	60 to 100 Per Cent	Range	4 to 17 Minutes
Median	92 Per Cent	Median	8.7 Minutes
Mean	86.6 Per Cent	Mean	8.8 Minutes
Per Cent of Hundreds	5.8	Standard	12 Minutes
Standard	100 Per Cent		(Preferably 5 Minutes)

TABLE XXIX. Distribution of Scores Relative to Time for the Eighth Grades on the Final A. P. Test.

Time in Minutes

Score	4	4½	5	5½	6	6½	7	7½	8	8½	9	10	10½	11	12	13	14	15	18	19	Total	Per Cent
100	1	1						2	1				1						1	1	8	21.1
96				1	1		1			1	1						1				6	15.8
92		2	3			1	1					1						1			9	23.7
88	1	1		1	1		1			1					1						7	18.4
84														1			1				2	5.2
80							1	1						1							2	5.2
76				1									1								2	5.2
60											1										1	2.6
56									1												1	2.6
Total	2	4	3	3	2	1	4	2	2	2	2	1	2	2	1		2	1	1	1	38	99.8

Score

Range 56 to 100 Per Cent
Median 92 Per Cent
Mean 89.9 Per Cent
Per Cent of Hundreds 21.0
Standard 100 Per Cent

Time

Range 4 to 19 Minutes
Median 7.2 Minutes
Mean 8.3 Minutes
Standard 12 Minutes
(Preferably 4 Minutes)

TABLE XYY. Distribution of Scores Relative to Time for the Fifth Grade, Lyndonville Graded School, on the Final M. P. Test.

Time in Minutes

Score	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	Total	Per Cent
100	1									1									2	10.6
96		1	1		1		1		1										5	26.3
92					1								1						2	10.6
88						1								1			1		3	15.3
84															1	1			2	10.6
76					1						1		1						3	15.3
72				1															1	5.3
52										1									1	5.3
Total	1	1	1	1	3	1	1		1	2	1		2	1	1	1	1		19	99.3

Score		Time	
Range	52 to 100 Per Cent	Range	6.5 to 14.5 Minutes
Median	88 Per Cent	Median	10 Minutes
Mean	86.7 Per Cent	Mean	10.1 Minutes
Per Cent of Hundreds	10.6	Standard	20 Minutes
Standard	100 Per Cent		(Preferably 8 Minutes)

---

one error each, and 2 others made two errors each.

The time ranged from 6.5 minutes to 14.5 minutes, with a median of 10 minutes and a mean of 10.1 minutes. The standard for the fifth grade in multiplication is from 8 minutes to 20 minutes, preferably 8 minutes. (See Table XXX)

(b) Sixth Grade -- 22 pupils

Multiplication Process Test (M. P. Test)

The range of scores in the M. P. Test ranged from 76 per cent to 100 per cent, with a median of 92 per cent and a mean of 89.6 per cent. One pupil, or 4.5 per cent of

TABLE XXXI. Distribution of Scores Relative to Time for the Sixth Grade, Lyndonville Graded School, on the Final M. P. Test.

Time in Minutes

Score	5	5½	6	6½	7	7½	8	8½	9	10	11	13	14	15	Total	Per Cent
100							1								1	4.5
96				2	1				1						4	18.2
92	2		1	1			1	1			1			1	8	36.4
88	1	1								1					3	13.6
84				2								1			3	13.6
80				1									1		2	9.0
76												1			1	4.5
Total	3	1	1	6	1	2	2		1	1		2	1	1	22	99.8

Score	Time
Range 76 to 100 Per Cent	Range 5 to 15 Minutes
Median 92 Per Cent	Median 7 Minutes
Mean 89.6 Per Cent	Mean 8.4 Minutes
Per Cent of Hundreds 4.5	Standard 15 Minutes
Standard 100 Per Cent	(Preferably 7 Minutes)

---

the sixth grade, achieved the 100 per cent goal: 4 pupils made one error each, and 8 others made two errors each.

The time ranged from 5 minutes to 15 minutes, with a median of 7 minutes and a mean of 8.4 minutes. The standard for sixth grade is from 7 to 15 minutes, preferably 7 minutes. (See Table XXXI)

(c) Seventh Grade -- 22 pupils

Multiplication Process Test (M. P. Test)

The range of scores in the M. P. Test ranged from 68 per cent to 100 per cent, with a median of 86 per cent

TABLE XXXII. Distribution of Scores Relative to Time for the Seventh Grade, Lyndonville Graded School, on the Final M. P. Test.

Time in Minutes

Score	5	6	6½	7	8	8½	9	10	10½	11	11½	14	17½	21	22	28	Total	Per Cent
100		1															1	4.5
96	1				1				1								3	13.6
92			1						1								2	9.0
88					2			1		1					1		5	22.7
84				1		1						1					3	13.6
80		1								1	1			1			4	18.2
76	1												1			1	3	13.6
68			1														1	4.5
Total	2	2	2	1	3	1	1	2	2	1	1	1	1	1	1	1	22	99.7

Score		Time	
Range	68 to 100 Per Cent	Range	5 to 28 Minutes
Median	86 Per Cent	Median	9.7 Minutes
Mean	80.9 Per Cent	Mean	11.1 Minutes
Per Cent of Hundreds	4.5	Standard	12 Minutes
Standard	100 Per Cent		(Preferably 6 Minutes)

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and a mean of 80.9 per cent. One pupil, or 4.5 per cent of the grade, achieved the 100 per cent goal; 3 pupils made one error each, and two others made two errors each.

The time ranged from 5 minutes to 28 minutes, with a median of 9.7 minutes and a mean of 11.1 minutes. The standard for seventh grade is from 6 minutes to 12 minutes, preferably 6 minutes. (See Table XXXII)

(d) Eighth Grade -- 19 pupils

Multiplication Process Test (M. P. Test)

The scores in the M. P. Test ranged from 72

TABLE XXXIII. Distribution of Scores Relative to Time for the Eighth Grade, Lyndonville Graded School, in the Final M. P. Test.

	Time in Minutes															
Score	4	5	5½	6	7	8	9	11	12	13½	16	16½	18	22	Total	Per Cent
100	1	1		1	2										5	26.3
96			1	1			1	1	1	1	1				7	37.0
92					1	1			1			1			4	21.9
88														1	1	5.2
80													1		1	5.2
72													1		1	5.2
Total	1	1	1	2	3	1	1	1	2	1	1	1	2	1	19	100.8

Score	Time
Range 72 to 100 Per Cent	Range 4 to 22 Minutes
Median 96 Per Cent	Median 9 Minutes
Mean 93.6 Per Cent	Mean 10.7 Minutes
Per Cent of Hundreds 26.3	Standard 12 Minutes
Standard 100 Per Cent	(Preferably 6 Minutes)

per cent to 100 per cent, with a median of 96 per cent and a mean of 93.6 per cent. Five pupils, or 26.3 per cent of the grade, achieved the 100 per cent goal; 7 pupils made one error each, and 4 others made two errors each.

The time ranged from 4 minutes to 22 minutes, with a median of 9 minutes and a mean of 10.7 minutes. The standard for the eighth grade is from 6 minutes to 12 minutes, preferably 6 minutes. (See Table XXXIII)

Table XXXIV (March columns) shows on a percentage basis the distribution of scores for all grades in the addition process in the final testing in the Wilson Diagnostic and Remedial

TABLE XXXIV. Distribution of Scores on a Percentage Basis for All Grades on the Initial and Final (Wilson) A. P. Tests.

Score	Fourth Grades 57 Pupils		Fifth Grades 38 Pupils		Sixth Grades 52 Pupils		Seventh Grades 34 Pupils		Eighth Grades 38 Pupils	
	Dec.	Mar.	Dec.	Mar.	Dec.	Mar.	Dec.	Mar.	Dec.	Mar.
100	3.5	10.5	5.2		7.7	9.6	29.4	5.8	18.4	21.1
96	5.2	15.8	13.1	21.1	5.7	11.5	11.7	32.3	26.3	15.8
92	5.2	3.5		13.1	21.1	26.9	8.8	17.6	18.4	23.7
88	10.5	5.2	21.1	7.8	7.7	7.7	2.9	11.7	5.2	18.4
84	12.2	7.0	10.5	13.1	15.4	7.7	2.9	5.8	2.6	5.2
80	8.7	19.3	7.8	18.4	5.7	17.3	8.8		2.6	5.2
76	10.5	5.2	10.5	7.8	7.7	7.7	8.8	5.8	5.2	5.2
72	12.2	7.0	2.6	7.8	5.7	1.9	8.8	2.9	2.6	
68	10.5	5.2	7.8	5.2	3.8	3.8	5.8	8.8	10.0	
64	1.7	7.0	2.6	2.6	5.7		2.9	5.8	2.6	
60	5.2	5.2	5.2		5.7	5.7	8.8	2.9		2.6
56	3.5	5.2	7.8		1.9				2.6	2.6
52	3.5	1.7								
48			2.6		1.9					
44			2.6		1.9					
40	3.5								2.6	
36	3.5	1.7								
32				2.6						
28					1.9					
Range	36-100	36-100	44-100	32-96	28-100	60-100	60-100	60-100	40-100	56-100
Median	76	80	82	84	84	88	88	92	92	92
Mean	74.8	78.3	78.4	82.8	79.7	85.8	85.1	86.6	86.8	89.9

TABLE XXXV. Distribution of Scores on a Percentage Basis for Lyndonville Graded School, Grades V-VIII, on the Initial and Final (Wilson) M. P. Test.

Score	Grade V 19 Pupils		Grade VI 22 Pupils		Grade VII 22 Pupils		Grade VIII 19 Pupils	
	Dec.	Mar.	Dec.	Mar.	Dec.	Mar.	Dec.	Mar.
100	5.3	10.6		4.5		4.5	5.2	26.3
96	10.6	26.3	4.5	18.2	9.0	13.6	20.9	37.0
92	5.3	10.6	18.2	36.4		9.0	20.9	21.9
88	10.6	15.3	27.2	13.6	9.0	22.7	15.6	5.2
84	5.3	10.6	13.6	13.6	18.2	13.6		
80	21.2		9.0	9.0	36.4	18.2	20.9	5.2
76	21.2	15.3	9.0	4.5	9.0	13.6		
72	5.3	5.3			4.5		10.5	5.2
68			9.0		9.0	4.5		
64	5.3		4.5		4.5		5.2	
60								
56	5.3							
52		5.3						
48	5.3							
28			4.5					
Range	48-100	52-100	28-96	76-100	64-96	68-100	64-100	72-100
Median	80	88	86	92	80	86	88	96
Mean	79.3	86.7	81	89.6	80.3	80.9	86.5	93.6

Test. At the left is found the scores arranged in descending order from 100 per cent to 32 per cent. Beside each score reading across the paper from left to right, is found the per cent of children in all grades receiving that score in the A. P. Test. Table XXXV (March columns) shows a similar summary for the pupils who were retested in the M. P. Test.

A second test, Form 2 of the Monroe Scales for Grade III, IV, and V, was also given. These were scored in exactly the same way as Form 1 and the results in per cent tabulated by schools and grades along with those of Form 1. (See Tables XXXVI and XXXVII, Final Test) In these tests perfect scores were precluded because of the time element in the administration of the tests.

In the following pages the results of the two testings will be compared.

TABLE XXXVI. Showing Gains (Column 5) on the Monroe Scales (for Grades III, IV, and V) between the Initial Testing in December (Column 3) and the Final Testing in March (Column 4). This table, therefore, shows comparative results of children retested in addition.

Addition Process -- 2.25 Minutes

School and Grade	No. of Pupils	Mean Score in Per Cent		Gain in Mean Score in Per Cent	Per Cent of Hundreds	
		Initial Test Form 1	Final Test Form 2		Initial Test Form 1	Final Test Form 2
Fletcher						
Grade IV	3	29.9	39.4	9.5		
V	2	53.1	62.3	9.2		
VI	5	45.9	52.3	6.4		
VII	1	83.5	91.7	8.2		
VIII	2	49.4	62.3	13.1		
Total or Average	12	52.3	61.6	9.3	None	None
Red Village						
Grade IV	1	35.0	35.0			
V	3	48.4	51.8	3.4		
VI	4	64.6	72.1	7.5		
VII	1	78.3	96.9	18.6		
Total or Average	9	57.5	63.9	6.4	None	None
East Burke						
Grade IV	7	20.9	29.6	8.7		
V	2	34.5	44.8	9.7		
VI	8	40.7	47.6	6.9		
VII	8	38.6	47.9	9.3		
VIII	3	47.4	57.0	9.6		
Total or Average	28	36.4	45.3	8.9	None	None
Sheffield						
Grade IV	5	26.4	43.7	17.3		
V	4	35.5	42.7	7.2		
VI	5	42.2	54.2	12.0		
VII	3	49.8	68.7	18.9		
VIII	4	54.8	66.7	11.9		
Total or Average	21	41.7	55.2	13.5	None	None

(continued on next page)

TABLE XXXVI. (concluded)

School and Grade	No. of Pupils	Mean Score in Per Cent		Gain in Mean Score in Per Cent	Per Cent of Hundreds	
		Initial Test Form 1	Final Test Form 2		Initial Test Form 1	Final Form 2
Wheelock						
Grades V	3	34.6	40.8	6.2		
VI	5	40.2	44.7	4.5		
VII	3	53.6	70.1	16.5		
VIII	6	44.8	49.3	4.5		
Total or Average	17	43.3	51.2	7.9	None	None
Lyndon						
Grades IV	11	38.7	60.7	22.0		
V	18	49.4	73.2	23.8		
VI	12	46.6	55.3	8.7		
VII	7	60.6	74.3	3.7		
VIII	9	63.1	71.4	8.3		
Total or Average	57	49.8	66.9	17.1	None	None
Lyndon-Center						
Grades IV	9	23.0	35.4	12.4		
V	5	35.8	55.1	19.3		
VI	14	40.2	56.8	16.6		
VII	10	42.0	49.9	7.9		
VIII	14	46.6	53.5	6.9		
Total or Average	52	37.5	50.1	12.6	None	None
Lyndonville						
Grade IV	21	27.1	46.9	19.8		
Total or Average	21	27.1	46.9	19.8	None	None

TABLE XXXVII. Showing Gains (Column 5) on the Monroe Scales (for Grades III, IV, and V) between the Initial Testing in December (Column 3) and the Final Testing in March (Column 4). This table, therefore, shows comparative results of children retested in multiplication.

Multiplication Process -- Time 2.25 Minutes

School and Grade	No. of Pupils	Mean Score in Per Cent		Gain in Mean Score in Per Cent	Per Cent of Hundreds	
		Initial Test Form 1	Final Test Form 2		Initial Test Form 1	Final Test Form 2
Lyndonville						
Grades V	20	36.7	49.3	12.6		
VI	21	43.5	51.5	8.0		
VII	22	49.5	53.7	4.2		
VIII	18	53.2	48.5	4.7		
Total or Average	81	45.7	50.7	5.0	None	None

gain of 7 per cent (See bottom of Table XXXIV). The median time was reduced 4 minutes and the mean time 0.9 minutes. (See Table XXXIV)

(b) Fifth Grades -- 38 pupils

Addition Process Test (A. P. Test)

In the fifth grade group in the A. P. Test the median score showed a gain of 2 per cent, and the mean score a gain of 4.4 per cent (See bottom of Table XXXIV). The median time was reduced 3.7 minutes and the mean time was increased 0.1 minute. There were no 100 per cent scores against 5.2 per cent in the initial testing. (See Table XXXIX)

(c) Sixth Grades -- 52 pupils

Addition Process Test (A. P. Test)

In the sixth grade group in the A. P. Test the median score showed a gain of 4 per cent, and the mean score a gain of 6.1 per cent. The per cent of hundreds increased 2 per cent. (See bottom of Table XXXIV) The median time was reduced 1 minute, and the mean time 1.3 minutes. (See Table XXXIX)

(d) Seventh Grades -- 34 pupils

Addition Process Test (A. P. Test)

In the seventh grade group in the A. P. Test the median score showed a gain of 4 per cent, and the mean score a gain of 1.5 per cent. The per cent of hundreds de-

creased 20.5 per cent. (See Table XXXIV) The median time was decreased 0.5 minutes, and the mean time 0.6 minutes. (See Table XXXIX)

(e) Eighth Grades -- 38 pupils

Addition Process Test (A. P. Test)

In the eighth grade group in the A. P. Test the median score showed no gain, but the mean score a gain of 3.1 per cent. The per cent of hundreds increased 2.7 per cent. (See Table XXXIV) The median time was decreased 0.3 minutes and the mean time (for 37 pupils) was 0.6 minutes. (See Table XXXIX)

By looking at Table XXXIV one sees that the same gain, 4 per cent, is made in the median scores in addition by grades four, six, and seven. In mean score grade six shows the greatest gain, 6.1 per cent.

By looking at Table XXXIX one sees the greatest improvement, 1.3 minutes, in mean time in grade six in the addition process.

Lyndonville Graded School

(a) Grade Five -- 19 pupils

Multiplication Process Test (M. P. Test)

In the fifth grade the median score in the M. P. Test showed a gain of 8 per cent, and the mean score a gain of 7.4 per cent. The per cent of hundreds showed a gain

of 5.3 per cent. (See bottom of Table XXXV) The median time was increased 2 minutes, and the mean time 1.5 minutes. (See Table XLI)

(b) Grade Six -- 22 pupils

Multiplication Process Test (M. P. Test)

In the sixth grade the median score in the M. P. Test showed a gain of 6 per cent, and the mean score a gain of 8.6 per cent. The per cent of hundreds showed a gain of 4.5 per cent. (See bottom of Table XXXV) The median time was decreased 4 minutes, and the mean time 3.7 minutes. (See Table XLI)

(c) Grade Seven -- 22 pupils

Multiplication Process Test (M. P. Test)

In the seventh grade the median score in the M. P. Test showed a gain of 6 per cent, and the mean score a gain of 0.6 per cent. The per cent of hundreds showed a gain of 4.5 per cent. (See bottom of Table XXXV) The median time increased 0.4 minutes, and the mean time remained the same. (See Table XLI)

(d) Grade Eight -- 19 pupils

Multiplication Process Test (M. P. Test)

In the eighth grade the median score in the M. P. Test showed a gain of 8 per cent, and the mean score 7.1 per cent. The per cent of hundreds showed a gain of 21.1 per

2. Comparison of the Results of the Initial and the Final Testing:- In order to justify the drill process as a satisfactory method of instruction, a comparison between the results of the December and the March testings should be made.

Tables XXXIV and XXXV are summary tables showing the distribution of scores on a percentage basis for all grades in one process,-either the addition or the multiplication process-for both the initial and the final testings. They are read as follows: A score of 100 was achieved in December by 3.5 per-cent, and in March by 10.5 per cent of all the fourth grades on the A. P. Test. Percentages for the other scores and for the other grades are read in a similar manner. A glance at the tables shows that a good many children have made an improvement during the six weeks' drill period but that only a small number have reached or approximated the 100 per cent goal.

All Schools Exclusive of Lyndonville Graded School, Grades V-VIII.

(a) Fourth Grades -- 57 pupils

Addition Process Test (A. P. Test)

In the fourth grade group the median score in the A. P. Test showed a gain of 4 per cent, and the mean score a gain of 3.5 per cent. The per cent of hundreds showed a

cent. (See bottom of Table XXXV) The median time increased 1.5 minutes, and the mean time 1.6 minutes. (See Table XLI)

By looking at Table XXXV one sees that the greatest gain in median scores in multiplication is made by grades five and eight--a gain of 8 per cent each; the sixth and seventh grades tie at a gain of 6 per cent. The greatest gain in mean score is made by grade six--a gain of 8.6 per cent. The fifth grade stands second with a gain of 7.4 per cent; the eighth grade third with a gain of 7.1 per cent; and the seventh grade fourth with a gain of 0.6 per cent.

By looking at Table XLI one sees the greatest improvement in mean time, in the M. P. Test, made in grade six--a gain of 3.7 minutes. The eighth grade stands second with an improvement of 1.6 minutes; the fifth grade third with an improvement of 1.5 minutes; and the seventh grade standing with the same time.

In order to give another picture of the results of the final testing in relation to the results of the initial testing, graphs of the mean scores made by the pupils in each grade for each test at both testing times are given. On these graphs a red bar is used to show the mean score in the initial testing and a blue bar to show the mean score in the final testing. This makes possible not only a comparison in one grade between the mean score achieved in December and the

mean score in March, but, in addition for each test, a comparison from grade to grade. (See Tables XXXVIII and XL)

On looking at the graphs of the addition process (Table XXXVIII) one sees the greatest improvement in the mean score in the sixth grades-a gain of 6.1 per cent. In Table XL the graphs of the multiplication process in the Lyndonville Graded School show the greatest improvement in the sixth grade -a gain of 8.4 per cent.

Similar graphs are shown of the mean time required by each grade for each test (in which the pupils were re-tested) both at the initial and the final testings. In the addition process very little improvement was made-in grades four, seven, and eight less than 0.1 per cent was made in each grade. Grades five and six required a little more time than in the initial testing. (See Tables XXXIX)

In the multiplication process the greatest improvement in mean time is made in grade six-a gain of 3.7 minutes. (See Table XLI)

By referring to Table XXXVI and Table XXXVII one sees the improvement made in all grades in either the addition or the multiplication process as evidenced by the Monroe Scales. In every grade with the exception of one fourth grade the mean score was raised from that obtained in the initial test.

From the information gained through the testing program,

TABLE XXXVIII. Comparative Mean Scores of Initial and Final Testings for All Grades on Wilson A. P. Test.

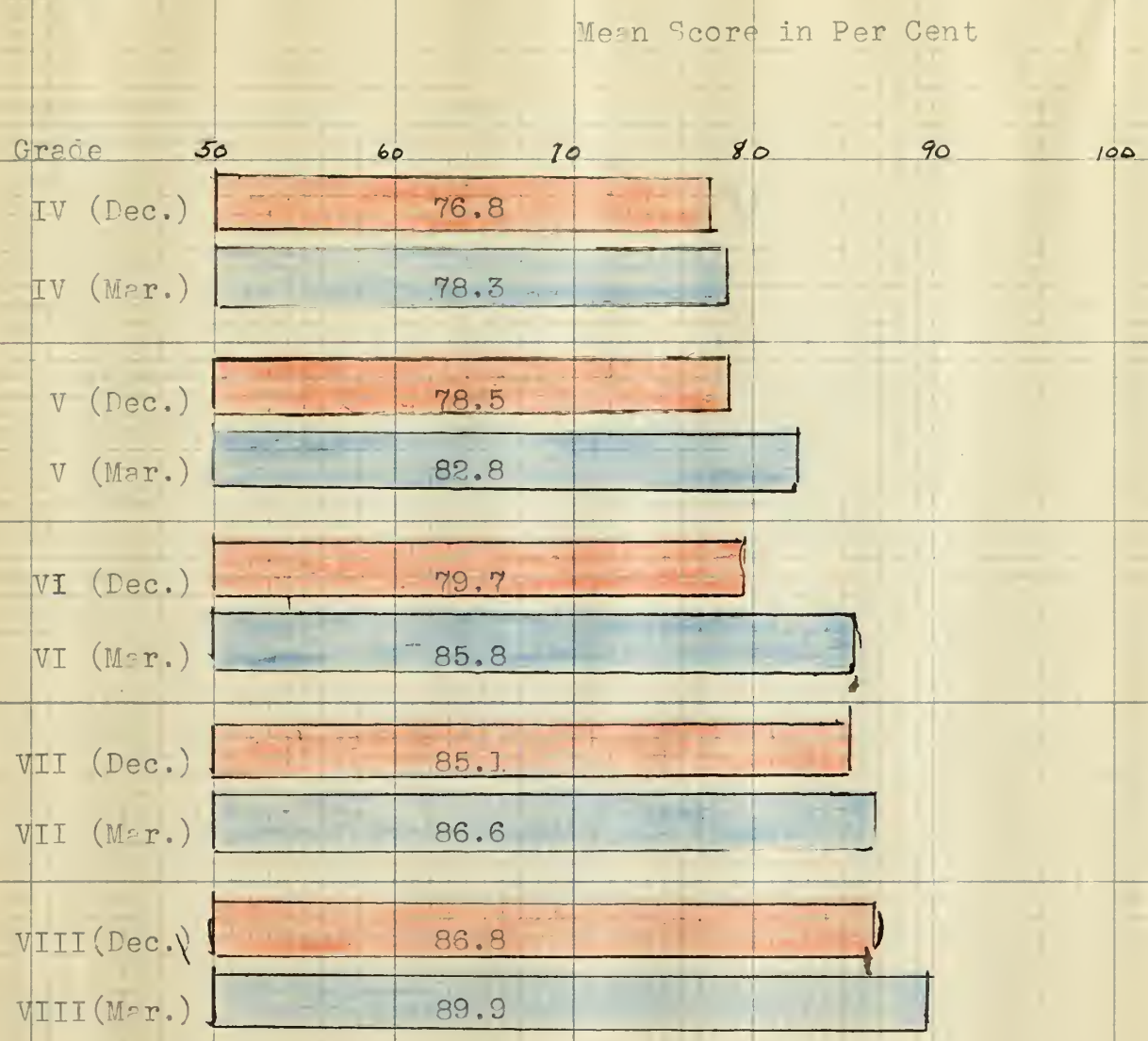


TABLE XXXIX. Comparative Mean Times for Initial and Final Testing for All Grades on Wilson A. P. Test.

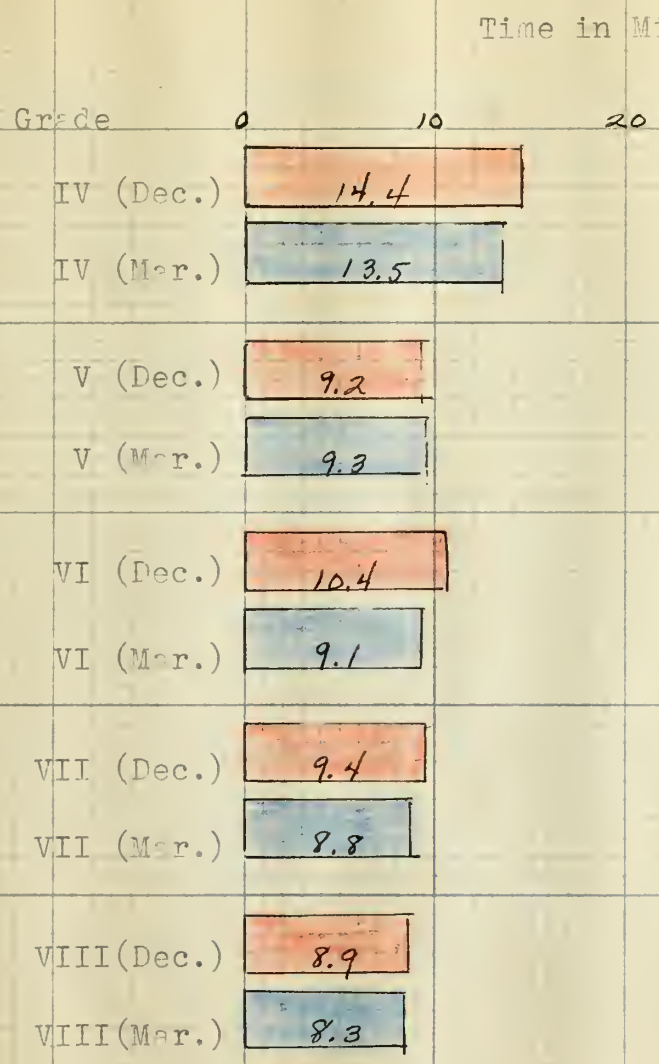


TABLE XL. Comparative Mean Scores of Initial and Final Testings for Lyndonville Graded School. Grades V-VIII, on the M.P. Tests.

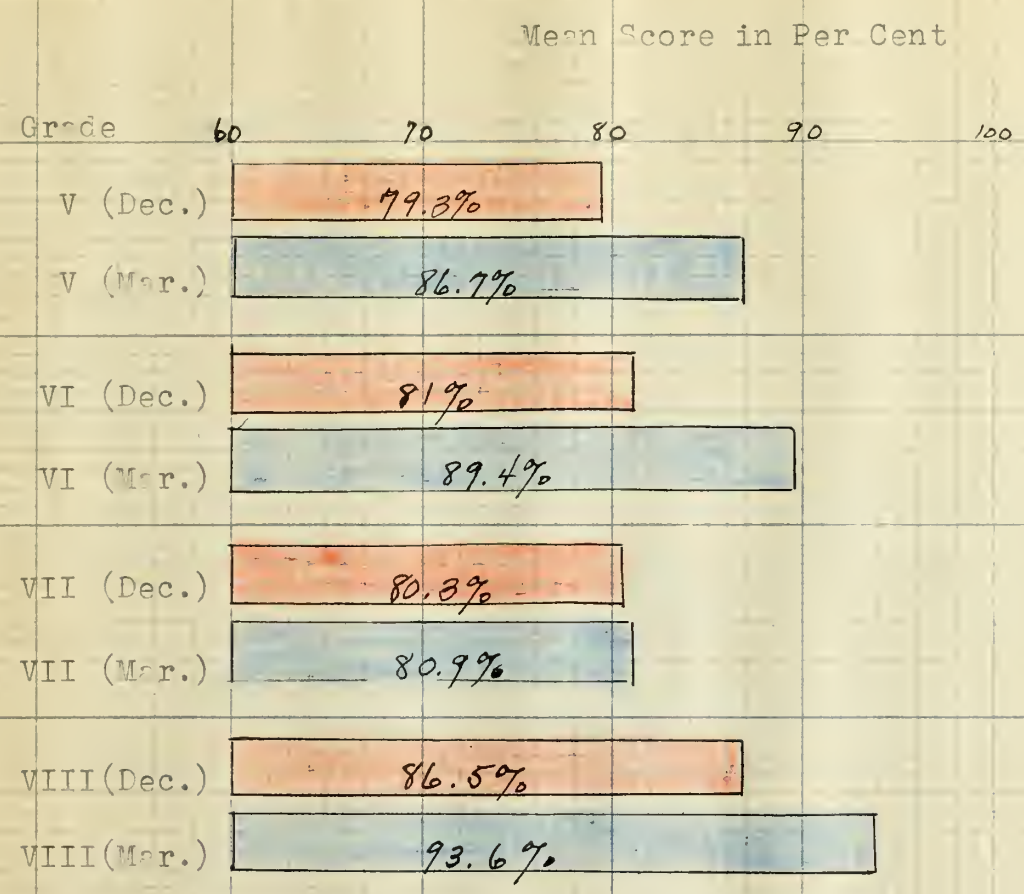
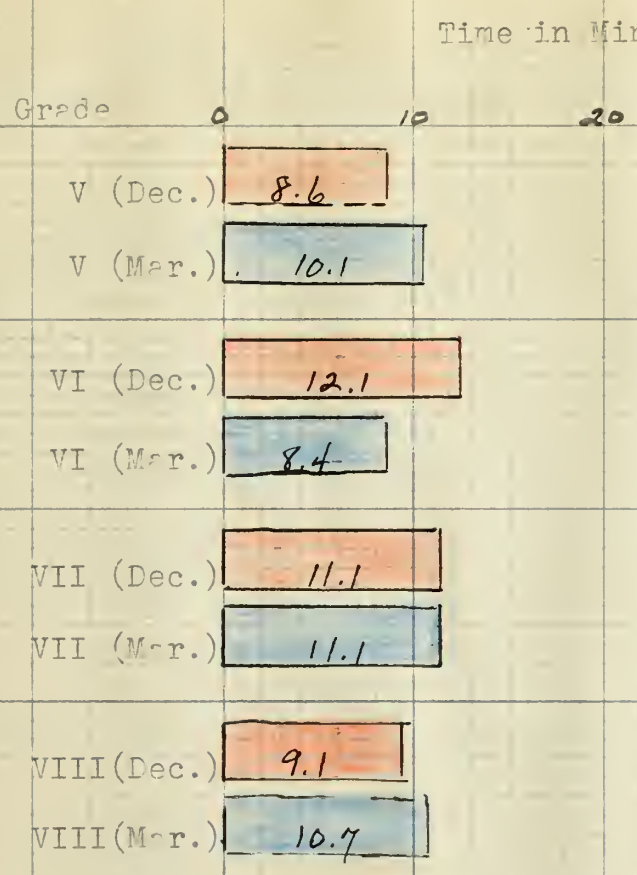


TABLE XLI. Comparative Mean Times of Initial and Final Testing for Lyndonville Graded School, Grades V-VIII, on the Wilson M. P. Tests.



it is seen that children do gain from systematic drill, even if it is concentrated in a short practice period, but that the results are achieved slowly.

Myers advised that accuracy be the first consideration. In any case there should be no time pressure. He says, "Contrary to present tendencies, data are available to show that the way to arrive at speed finally is to get accuracy first."[1/]

Table XLII and Table XLIII show the mean scores and times in the initial and final testings respectively in the addition process for some of the later studies including the present one. Table XLIV and Table XLV show the mean scores and times in the initial testings respectively in the multiplication process. The children in this present study seem to compare very favorably with the other groups in the initial tests. The mean scores in the final test do not stand as high as most of the mean scores in the other studies. This is probably largely due to the fact that the experiment was carried on for a much shorter period of time. However, the children improved their mean records from one to seven points.

1/ G. M. Myers, The Prevention and Correction of Errors in Arithmetic, p. 53.

TABLE XLII. Mean Scores and Times of Initial Testing for Earlier Studies (column 2-10) and Present Study (column 11) Wilson Inventory and Diagnostic A. P. Test.

1	2		3		4		5		6		7		8		9		10		11	
Grade	W.P.A. 1936		Henley 1938		Yarbrough 1938		Nelson 1938		Houghton 1939		Ridlon 1939		Ringer 1940		Earle 1940		Bancroft 1941		Present* Study 1942	
	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV			65	23											78	22			75	14
V			80	17													83	14	79	9
VI	89	9	88	13	86	12			79	13	83	10			90	12	87	9	80	10
VII									84	14			82	9					85	9
VIII	No re-tests						88	8	94	8			83	9	88	8	90	7	87	9
							No re-test													

* Scores of pupils re-tested in addition process.

TABLE XLIII. Mean Scores and Times of Final Testing for Earlier Studies (column 2-8) and Present Study (column 8) Wilson Inventory and Diagnostic A. P. Test.

1	2		3		4		5		6		7		8		9	
Grade	Hanley 1938		Yarbrough 1938		Houghton 1939		Ridlon 1939		Ringer 1940		Earle 1940		Bancroft 1941		Present* Study 1942	
	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
IV	80	18													78	14
V	84	13											94	7	83	9
VI	90	13	96	9	95	7	91	10			90	10	94	7	86	9
VII					97	9									86	9
VIII					99	6			99	9	95	8	97	5	90	8

* Scores of pupils re-tested in addition.

XLIV. Mean Scores and Times of Initial Testing for Earlier Studies (column 2-10) and Present Study (column 11) Wilson Inventory and Diagnostic M. P. Test.

1	2		3		4		5		6		7		8		9		10		11	
Grade	W.P.A. 1936		Hanley 1938		Yarbrough 1938		Nelson		Houghton 1939		Ridlon 1939		Ringer 1940		Earle 1940		Bancroft 1941		Present* Study 1942	
	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
V			58	42													65	21	79	9
VI	77	11	82	33	75	16			56	21	58	14			75	15	77	14	81	12
VII									76	18			73	10					80	11
VIII							80	10	81	12			73	10	81	9	84	10	87	9

* Scores of pupils re-tested in Multiplication process.

TABLE XLV. Mean Scores and Times of Final Testing for Earlier Studies (column 2-8) and Present Study (column 9) Wilson Inventory and Diagnostic M. P. Test.

1	2		3		4		5		6		7		8		9	
Grade	Hanley 1938		Yarbrough 1938		Houghton 1939		Ridlon 1939		Ringer 1940		Earle 1940		Bancroft 1941		Present* Study 1942	
	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.	Sc.	T.
V													92	10	87	10
VI	80	17	92	12	96	12	83	11			88	12	94	9	89	8
VII					98	9									81	11
VIII					99	9			96	10	94	10	95	7	94	11

* Scores of pupils re-tested in multiplication process.

CHAPTER V

SUMMARY AND CONCLUSIONS

In December 1941, the Wilson A. P. and S. P. Tests were administered in all grades from the fourth to the eighth inclusive, and the M. P. Test from the fifth to the eighth inclusive in eight rural and village schools in the North District of Caledonia County in northern Vermont. A total of 313 children was tested by the regular room teachers. A second test, the Monroe standardized scale, Form 1 for grades 3, 4, and 5 was also administered in the same month.

In March 1942, the same Wilson tests either in addition or multiplication were administered to the groups followed by Form 2 of the Monroe scale. In each grade group the results of the March tests were compared with the results of the December tests in both the Wilson tests and the Monroe scales respectively.

The conclusions arising from the study seem to the writer to be as follows:

1. Country children as well as city children are unquestionably in need of a great deal of remedial work in the

fundamentals of addition, subtraction, and multiplication. The need begins in the fourth grade and extends through the elementary school.

2. Pupils improve through the use of corrective measures. The improvements are slow.

3. The amount of time needed to take a class to the 100 per cent mastery or more nearly to it, is longer than a six weeks' period.

4. Teachers can do effective corrective work in the limited amount of time devoted to such procedures.

5. Teachers realize the need of doing corrective work in the fundamental processes and understand that good teaching and a generous length of time are necessary to bring children to a satisfactory goal.

Thus, one more study in the elementary field reveals the need of corrective work in the fundamental processes and shows that gains which merit only a small degree of satisfaction can be achieved in a few weeks.

At present the traditional drill load in these schools is carried on with small profit. What can be done to improve the situation in these four Vermont towns? Is it not possible for the classroom teachers, the superintendent, and the supervisors to lay out cooperatively a long time plan - perhaps a five-year plan - wherein the drill load will be reduced and redistributed throughout the eight grades?

Adequate surveys[1] show that much of the traditional drill load is useless. For example, they show that the average citizen has little computational use for decimals except in handling United States money; that the fractions - halves, thirds, and fourths - cover 90 per cent of adult usage and 40 per cent of usage in big business; and that the usual school work in denominate numbers and measures is merely school exercises having no counter-part of life outside. In short, as has been before quoted from Wilson, "Ninety-five per cent of adult figuring is covered by the four fundamental processes, simple fractions, percentage and interest."[2]

Can not practical use be made of these surveys and a reduction in the drill load be brought about? In other words, can not dead subject matter be eliminated from the drill curriculum?

Other studies show that grade placement of subject matter is important in achieving better results. Washburne says, "Every child wants to learn. It is when we try to force unsuitable subject matter on unready children that we get the impression that learning is distasteful." Again he says,"Be sure that the kind of learning we put before them, is a learning for which they are psychologically ready, and then serve

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1/ G. M. Wilson, op. cit., Chapters II, III, VII-X.
G. M. Wilson, Mildred B. Stone, and others, op. cit., Chapters 13, 17, and 18.

2/ Ibid. p. 35.

it appetizingly." And again,

> "We know that school starts all formal teaching too soon.-----There are some striking facts that point to the desirability of postponing all systematic learning of the three R's until children are seven and one-half or eight years of age mentally. They can learn then more effectively and with more satisfaction and permanence for their waiting, provided that their first year or two in school consists of educational experiences.----With such a foundation, the children, when they begin to study the three R's, do so with zest and such a feeling of security that in the next two or three years they overtake and go considerably past the children who began drilling at six."1/

Is it not possible this year to lead the pupils of the first and second grades into many meaningful number experiences and delay the formal drill in addition until the third year? Can not the remainder of the drill program be redistributed to meet the mental maturity of the children and still be completed with a reasonable measure of success by the end of the elementary school?

These two factors, reduction in the drill load and better grade placement, combined with the understanding of good teaching will do much toward bringing a feeling of security to those who sit as learners and a great incentive and an inspiration to those who set the stage for the learning process. Thus the

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1/ C. W. Washburne, "Fit the Course of Study to the Child", National Parent Teacher; 31: 4-5. (August 1937)

challenge - improvement in the fundamentals of arithmetic through a more meaningful use of Vermont opportunities and situations!

APPENDIX

Scale I
For Grades 3, 4 and 5
Form 1

Published by the
Public School Publishing Co.
Bloomington, Illinois
Printed in U. S. A.

Score_____

MONROE'S STANDARDIZED GENERAL SURVEY ARITHMETIC SCALES

Name..... Boy or Girl.....

Age last birthday..... Next birthday will be.....19.....

Grade..... Date..... City..... State.....

School..... Teacher.....

Test No. 1—ADDITION

No. Right_____ ÷ 3 =_____

1	4	6	1	9	7	0	9	3	6	2	0	1
2	2	6	3	5	7	1	6	0	9	4	7	5
3	3	8	9	1	7	4	8	8	2	0	2	0
2	8	1	9	6	6	7	0	9	5	5	7	8
3	3	4	1	7	2	5	8	6	6	7	9	5
1	5	6	4	9	9	8	3	0	5	2	0	1
4	2	5	9	7	7	4	4	8	0	5	3	0
3	2	2	3	1	8	9	0	6	0	7	4	4
9	6	2	2	4	3	5	7	1	9	6	0	4
1	3	8	1	8	3	9	4	0	8	2	6	5

Test No. 2—SUBTRACTION

No. Right_____ ÷ 3 =_____

9	12	7	1	11	9	8	13	4	12
9	3	3	0	6	7	1	8	3	7
12	5	8	10	11	6	11	2	15	7
6	1	0	2	9	0	7	1	8	5
10	13	12	3	10	4	1	8	6	4
9	7	4	2	5	2	1	3	3	4
15	10	13	8	10	17	9	6	5	11
9	7	5	6	1	9	4	4	5	8
5	16	12	7	15	8	5	16	11	9
0	8	9	0	6	5	3	7	4	1

Test No. 3—MULTIPLICATION

No. Right _____ ÷ 2 = _____

3	2	9	4	0	7	5	4	4	9
2	9	8	7	2	6	6	0	1	5
9	6	5	2	4	3	7	9	0	7
1	5	2	1	8	3	0	6	5	7
7	0	1	8	2	7	3	1	9	4
4	6	6	3	8	1	8	5	9	4
2	8	4	0	4	0	1	9	6	1
0	9	3	3	5	7	4	3	2	7
8	3	6	6	0	7	3	5	2	4
8	4	8	3	0	9	9	5	2	6

Test No. 4—DIVISION

No. Right _____ ÷ 3 = _____

3) 9	7)28	4)32	9) 9	6)36	3)21	2) 0
6)48	1) 1	7)63	5)10	6) 0	2) 6	8)32
4)24	1) 8	5)30	1) 7	8)72	2)10	1) 0
7)42	9)36	1) 1	6)18	1) 3	3) 6	2) 8
4)20	6) 6	7)49	3)27	8)64	3)24	1) 2
9)63	4)16	2) 4	5) 0	8)24	7) 7	7)21
2)18	4) 4	6)42	3)15	3) 0	7) 0	9)81

Test No. 5—ADDITION

No. Right _____ ÷ 2 = _____

5	6	2	1	9	4	2	9
2	3	8	4	8	6	8	7
2	4	8	2	0	5	5	1
0	8	5	5	7	3	0	5
4	8	1	4	6	4	6	3
—	—	—	—	—	—	—	—
6	5	2	4	6	1	8	3
7	9	7	0	2	4	5	7
8	6	3	8	3	1	1	2
5	3	4	5	9	8	3	9
5	8	1	5	3	4	8	6
—	—	—	—	—	—	—	—
7	9	3	8	4	1	1	4
5	3	6	6	2	3	6	7
3	7	7	2	5	9	9	5
3	8	1	4	4	3	7	1
1	3	6	1	1	5	5	0
—	—	—	—	—	—	—	—
1	2	7	5	9	8	5	6
0	9	3	5	8	2	4	6
5	0	1	9	5	3	2	7
2	5	5	3	4	2	4	2
6	2	4	1	9	5	2	7
—	—	—	—	—	—	—	—

Test No. 6—SUBTRACTION

No. Right _____

37	94	60	27	39	41	77	53
5	8	3	6	7	8	3	9
—	—	—	—	—	—	—	—
65	80	92	70	68	58	26	43
2	4	5	3	2	9	9	8
—	—	—	—	—	—	—	—
95	50	36	34	44	25	63	57
4	7	1	8	6	3	7	9
—	—	—	—	—	—	—	—
45	60	29	90	33	81	54	71
8	5	2	6	4	5	7	4
—	—	—	—	—	—	—	—

Test No. 7—MULTIPLICATION

No. Right_____

6572 6	6750 9	5863 2	3754 5	2845 8
4936 4	9327 7	8274 3	8409 6	6391 9
5482 2	8609 5	3679 8	2758 4	4658 7
9653 3	3174 6	2874 9	7901 2	2179 5

Test No. 8—DIVISION

No. Right_____

8)3840	4)7432	7)2534	3)8430	6)4680
9)8577	2)6370	5)9310	8)7512	4)3820
7)9653	3)5781	6)6720	9)5373	2)5130
6)7188	9)2142	5)4350	3)2616	7)3038

Score_____

Time_____

THE WILSON INVENTORY AND DIAGNOSTIC TESTS IN ARITHMETIC

By GUY M. WILSON, Ph.D.

Test S P Subtraction Process Step Difficulties

Name_____ Age_____ Grade_____ Building_____ City_____

To the Pupil: **Subtract** in this test.

If you hesitate, place a check (√).
If you count, double check (√√).

Note time when you start_____: when you stop_____.
The score is the number right times 4.

(a)									
8	7	9	5	8	6	9	7	6	9
7	0	3	0	5	4	6	7	0	8

(b)								
10	14	17	13	13	14	12	11	13
6	5	8	9	5	7	3	2	7

(c)						
67	837	37	864	58	98	425
51	426	22	632	31	58	325

(d)				
84	736	92	1322	1133
34	336	62	997	766

(e)	(f)	(g)	(h)	(i)	(j)	(k)
1189	7558	4282	715	6303	4544	829
453	3009	120	236	1400	916	57

(l)	(m)	(n)	(o)	(p)	(q)	(r)
9261	5331	1420	4700	7849	15098	1491
4780	2186	1254	1432	1991	8020	843

(s)	(t)	(u)	(v)	(w)	(x)	(y)
1302	1276	$5.00	$55.40	$8.10	$25.10	$14.00
804	897	1.51	42.25	5.98	17.05	9.98

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THE PALMER COMPANY, Publishers
Boston, Massachusetts

ANALYSIS OF ERRORS — SUBTRACTION

For each error made in the test, there should be a tally entered in the right place on this plan.

1. Adding instead of subtracting _____
2. Borrowing, failing to borrow when necessary _____
3. Borrowing, from second figure to left instead of first _____
4. Borrowing, increasing instead of decreasing minuend digit _____
5. Borrowing, not taking one away when borrowed _____

6. Borrowing, the one borrowed added as a unit _____
7. Borrowing too many; e.g., 2 or 3 instead of 1 _____
8. Borrowing, when unnecessary _____
9. Double borrowing _____
10. Triple borrowing _____

11. Combination errors, minuend under 10 _____
12. Combination errors, minuend 10 to 18 _____
13. Counting for answer _____
14. Cross subtraction _____
15. Lefts, dangling lefts ignored _____

16. Lefts, vanishing lefts brought down _____
17. Minuend figure brought down _____
18. Minuend, figure of minuend taken from subtrahend _____
19. Process not understood _____
20. Remainder figures reversed _____

21. Remainder, one borrowed put as next figure in remainder _____
22. Subtrahend figure brought down _____
23. Subtracting units only _____
24. Unknown combinations derived from known _____
25. Zero, when remainder is zero, bringing down figure of subtrahend or minuend _____

26. Zero, subtracting some number from 0 = 0 _____
27. Zero, subtracting some number from 0 = subtrahend figure _____
28. Zero subtracted from some number = 0 _____
29. Other zero difficulties _____
30. Dollars and cents _____

31. _____ _____
32. _____ _____
33. _____ _____
34. _____ _____
35. _____ _____

Score Any score less than 100 calls for corrective work. Find your errors and card the facts missed.

Time If the time is too long it indicates unsatisfactory habits of work. For this test, the time should not be greater than:

20 minutes in grade 3; better if only 10 minutes.
15 minutes in grade 4; better if only 8 minutes.
12 minutes in grade 5; better if only 6 minutes.
12 minutes in grade 6; better if only 5 minutes.
10 minutes in grade 7; better if only 5 minutes.
10 minutes in grade 8; better if only 4 minutes.

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